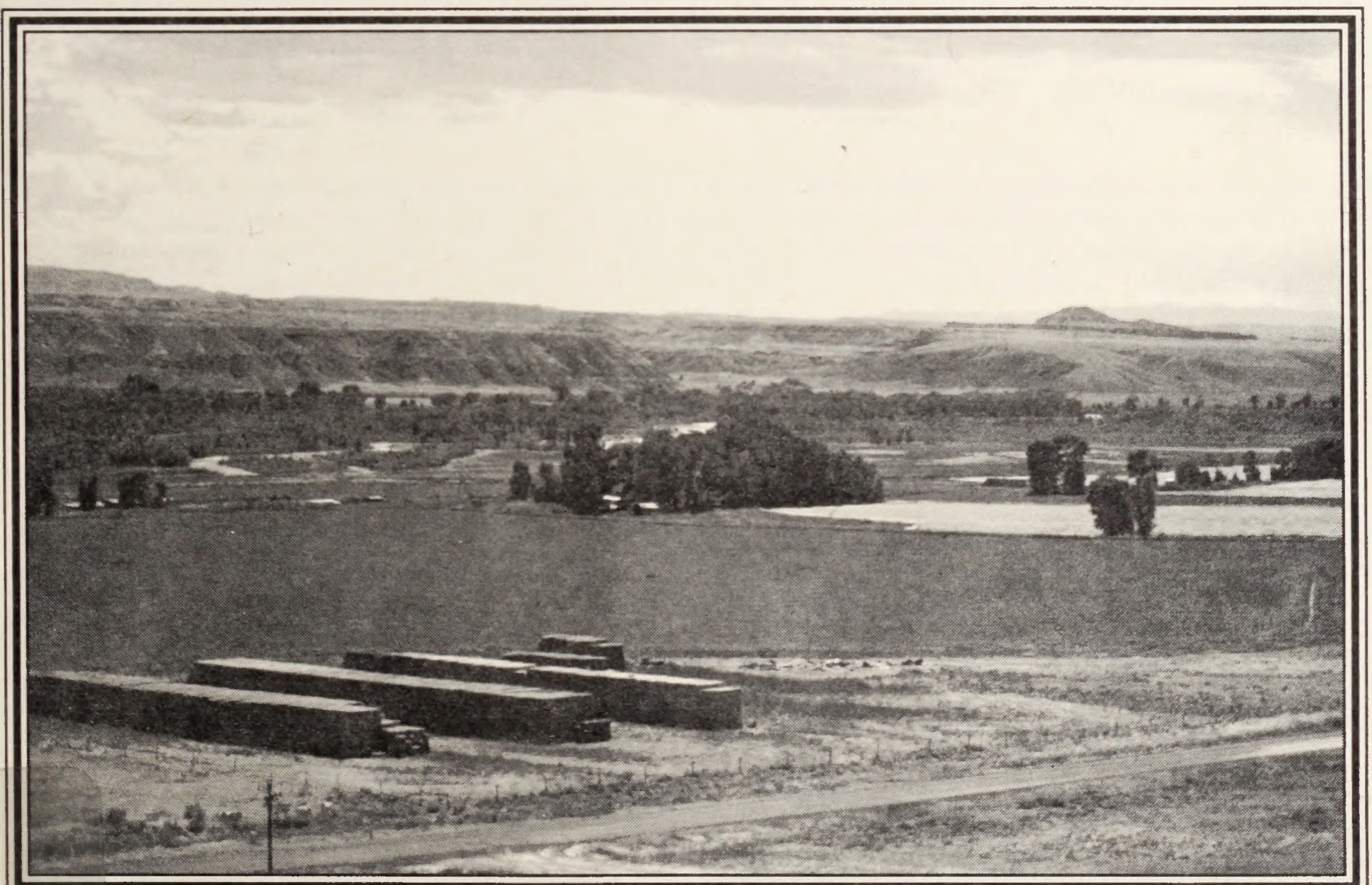
U.S. Department of the Interior
Bureau of Land Management
U.S. Army Corps of Engineers

Worland District Office, Bighorn Basin Resource Area December 1996

DRAFT
Greybull Valley Dam and Reservior Environmental Impact Statement



The Bureau of Land Management is responsible for the balanced management of the public lands and resources and their various values so that they are considered in a combination that will best serve the needs of the American people. Management is based upon the principles of multiple use and sustained yield; a combination of uses that take into account the long term needs of future generations for renewable and nonrenewable resources. These resources include recreation, range, timber, minerals, watershed, fish and wildlife, wilderness and natural, scenic, scientific and cultural values.

BLM/WY/PL-97/004+1010

U.S. Department of the Interior
Bureau of Land Management
P. O. Box 1828 (5353 Yellowstone Rd.)
Cheyenne, Wyoming 82003-1828

U.S. Department of the Army
Corps of Engineers, Omaha District
215 North 17th Street
Omaha, Nebraska 68102-4978

WYW-131027

December, 1996

Dear Reader:

This draft Environmental Impact Statement (DEIS) is prepared pursuant to 40 CFR 1500-1580 on the proposed Greybull Valley Irrigation District Dam and Reservoir Project and is submitted for your review and comment. The DEIS documents the analysis of the potential impacts of a 150-foot high zoned-earth embankment dam and a 33,470-acre-foot impoundment in an unnamed drainage west of Roach Gulch which is south of the Greybull River. Also considered are an alternate location in Blackstone Gulch and the No Action Alternative. The Bureau of Land Management (BLM) must decide whether or not to issue a right-of-way for the project on the affected public lands. The U.S. Army Corps of Engineers must decide whether or not to issue required permits under Section 404 of the Clean Water Act.

If you wish to comment on the DEIS, we request that you make your comments as specific as possible. Comments will be more helpful if they include suggested changes, sources, or methodologies. Comments that contain only opinions or preferences will not receive a formal response in the Final EIS (FEIS); however, they will be considered and included as part of the BLM decision-making process. The public comment period for this DEIS will be 60 days from the date that the Environmental Protection Agency publishes their Notice of Availability in the Federal Register. The ending date for the comment period will be published in the local newspapers. Please send written comments to the Bureau of Land Management; Worland District Office; Attn: Don Ogaard, BLM Project Manager; P.O. Box 119; Worland, Wyoming 82401-0119.

Comments, including names and street addresses of respondents, will be available for public review at the above address during regular business hours 7:30 a.m. to 4:30 p.m., Monday through Friday, except holidays, and may be published as part of the final Environmental Impact Statement (FEIS). Individual respondents may request confidentiality. If you wish to withhold your name or address from public review or from disclosure under the Freedom of Information Act, you must state this prominently at the beginning of your comment. Such requests will be honored to the extent allowed by law. All submissions from organizations or businesses, and from individuals identifying themselves as representatives or officials of organizations or businesses, will be made available for public inspection in their entirety.

The BLM's Preferred Alternative in this DEIS is Alternative B, Lower Roach Gulch (Proposed Action) as modified by the mitigation described in Chapter 5. The Army Corps of Engineers does not identify a Preferred Alternative.

Copies of this DEIS are available for public review at BLM Worland District office and the Wyoming State office in Cheyenne, WY; at the Corps offices in Cheyenne and Omaha, NE, and at local libraries. Because the FEIS may be issued in partial text format, you should keep this DEIS for future reference.

Sincerely,

Alan R. Pierson
Wyoming State Director
Bureau of Land Management

Candace Thomas

Candace M. Thomas, Chief
Environmental Analysis Branch, Planning Div.
Army Corps of Engineers, Omaha District

DRAFT

ENVIRONMENTAL IMPACT STATEMENT
for the
GREYBULL VALLEY IRRIGATION DISTRICT
DAM AND RESERVOIR PROJECT
in
PARK COUNTY, WYOMING

Bighorn Basin Resource Area
Worland District, Wyoming

Prepared for:

U.S. Department of the Interior
Bureau of Land Management
Worland, Wyoming

U.S. Department of the Army
Corps of Engineers, Omaha District
Omaha, Nebraska

Prepared by:

Western EcoSystems Technology, Inc.
Third Party Contractor
Cheyenne, Wyoming

1996

Alan R. Pierson
Wyoming State Director
Bureau of Land Management
U.S. Department of the Interior

12/16/96
Date

Candace M. Thomas, Chief
Environmental Analysis Branch
Planning Division
U.S. Army Corps of Engineers

12/18/96
Date

ACRONYMS AND ABBREVIATIONS USED IN DEIS

ac	acre
AF	Acre-Feet
AFS	American Fisheries Society
ALS	Advanced Life Support
AUM	Animal Unit Month
BG	Blackstone Gulch
BLM	Bureau of Land Management
BOR	Bureau of Reclamation
bu	bushel
cfs	Cubic Feet per Second
Corps	U.S. Army Corps of Engineers
CFR	Code of Federal Regulations
CWA	Clean Water Act
cwt	hundred weight
dBA	Decibels
DDE	dichloro-bis-chlorophenyl-ethene
DDT	dichloro-diphenyl-trichloro-ethane
DEIS	Draft Environmental Impact Statement
DO	dissolved oxygen
EPA	Environmental Protection Agency
ESA	Endangered Species Act
EIS	Environmental Impact Statement
FEIS	Final Environmental Impact Statement
GEI	GEI Consultants, Inc.
GVID	Greybull Valley Irrigation District
GR	Greybull River
HEC-RAS	Hydrologic Engineering Center - River Analysis System
LRG	Lower Roach Gulch
$\mu g/m^3$	micrograms per cubic meter
$\mu g/L$	micrograms per liter
$\mu g/Kg$	micrograms per kilogram
mph	miles per hour
mg/L	milligrams per liter
NEPA	National Environmental Policy Act
NPDES	National Pollution Discharge Elimination System
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resource Conservation Service
NSO	No Surface Occupancy
NTU	Nephelometric Turbidity Units
NWI	National Wetland Inventory
OPSTUDY	Operations Study
POD	Period of development
PCBs	Polychlorinated biphenyls
PHABSIM	Physical Habitat Simulation
PILT	Payment In Lieu of Taxes
PLS	Pure Live Seed
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PSD	Prevention of Significant Deterioration
REA	Rural Electrical Association
RMH	Rocky Mountain Herbarium
ROD	Record of Decision
ROW	right-of-way
RV	recreational vehicle
SAR	Sodium Absorption Ratio
SCORP	State Comprehensive Outdoor Recreation Plan
SD	standard deviation
SLAMS	State and Local Air Monitoring Station
SMPDBK	Simplified Dam Break Flood Forecasting Model
STORET	Storage and Retrieval System Water Quality Database
SWWRC	States West Water Resources Corporation
T&E	Threatened and Endangered Species
TDS	Total Dissolved Solids
TNC	The Nature Conservancy
TSP	Total Suspended Particulates
TSS	Total Suspended Sediment
USDA	United States Department of Agriculture
USDC	United States Department of Commerce
USDI	United States Department of Interior
USDOT	United States Deparment of Transportation
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VRM	Visual Resource Management
WDAI	Wyoming Department of Administration and Information
WDCI	Wyoming Department of Criminal Investigation
WDT	Wyoming Department of Tourism
WEST	Western EcoSystems Technology, Inc.
WGFD	Wyoming Game and Fish Department
WDEQ	Wyoming Department of Environmental Quality
-AQD	WDEQ - Air Quality Division
-WQD	WDEQ - Water Quality Division
WNDD	Wyoming Natural Diversity Database
WOS	Wildlife Observation System
WSEO	Wyoming State Engineer's Office
WYDOT	Wyoming Department of Transportation
WUA	Weighted Usable Area
WWDC	Wyoming Water Development Commission

SUMMARY

GREYBULL VALLEY DAM AND RESERVOIR DRAFT ENVIRONMENTAL IMPACT STATEMENT

December 1996

Co-lead agencies: U.S. Department of the Interior
Bureau of Land Management, Worland District Office
Worland, Wyoming

and

U.S. Department of the Army
Corps of Engineers, Omaha District
Omaha, Nebraska

Additional information can be obtained from the following:

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Worland, WY 82401
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ABSTRACT -- The Draft Environmental Impact Statement (DEIS) discloses the environmental impacts from the Greybull Valley Irrigation District's plan to construct an off-channel dam and reservoir to supply irrigation water to farmers in the lower Greybull River Valley. Three alternatives were evaluated: the Lower Roach Gulch Reservoir, the Blackstone Gulch Reservoir and the No Action Alternative. Issues identified during the scoping process are evaluated including land resources, water quality, wetland and riparian resources, streamflow changes, the need for supplemental irrigation water, air quality, noise, biological resources, threatened and endangered species, aquatic resources, socioeconomic resources, cultural resources, recreational resources, aesthetics, private property, dam safety, and purpose and need for the project. This is a summary of the DEIS.

A complete copy of the DEIS can be obtained from the Worland District Office of the Bureau of Land Management. Comments are solicited on all aspects of the DEIS and will be considered in the preparation of the Final EIS. Comments should be sent to Don Ogaard by March 7, 1997 at the above address.

Prepared by:
Western EcoSystems Technology, Inc.
2003 Central Ave., Cheyenne, WY 82001

GREYBULL VALLEY DAM AND RESERVOIR DEIS SUMMARY

INTRODUCTION AND PROPOSED ACTION

The Greybull Valley Irrigation District (GVID) proposes construction of an off-channel dam and reservoir in Park County, Wyoming to supply irrigation water to farmers in the lower Greybull River Valley. The GVID has applied to the U.S. Army Corps of Engineers (Corps) for a permit, pursuant to Section 404 of the Clean Water Act, to discharge dredge or fill material into the waters of the U.S. The GVID has also submitted a right-of-way (ROW) application for the project to the United States Department of Interior, Bureau of Land Management (BLM) pursuant to Section 5 of the Federal Land Policy and Management Act (1976) and implementing regulations 43 CFR, part 2800.

GVID's proposal includes an earthen dam at the lower end of an unnamed gulch (ephemeral tributary of the Greybull River) immediately west of Roach Gulch[1]. Water for the reservoir would be diverted from the Greybull River and delivered to the reservoir via a 5-mile-long canal. Water would be released from the dam back to the Greybull River through the existing channel. The proposed reservoir would store approximately 33,470 acre-feet, and inundate approximately 700 acres.

The BLM and Corps determined that an analysis of the environmental effects of the project and reasonable alternatives was necessary to aid in decision making. This Draft Environmental Impact Statement (EIS) was prepared in accordance with the National Environmental Policy Act of 1969 (NEPA) as amended and provides a complete and objective analysis of environmental effects.

PURPOSE AND NEED

It is anticipated that water from the project would be used to supplement existing irrigation supplies for use in irrigating existing crops and previously tilled but presently idle land (with existing water rights). The GVID's purpose for the proposed dam and reservoir is to provide the lower Greybull River Valley agricultural community with supplemental irrigation water by:

- increasing water yield of the system during droughts,
- increasing efficiency of use of stored water to avoid waste, and
- providing timely delivery of water to irrigators.

The purpose of the project from the public's perspective is to provide a reliable supplemental irrigation water supply for the lower Greybull River Valley agricultural community.

The lower Greybull River Valley is within one of the most arid regions in Wyoming, averaging approximately 8" of precipitation a year. Little crop production would be possible in the area without irrigation. Irrigators in the Greybull River Valley have over 88,000 acres permitted for irrigation and currently irrigate approximately 65,000 acres. Approximately one-half of the irrigated lands in the

[1] The name Lower Roach Gulch is assigned to this proposal because it is referred to by this name in most of the previous documents and reports pertaining to the project and this name is in common use locally, within the agencies, and the GVID

GVID (33,500 acres) are served by the Farmers and Bench canals, which divert water from the lower Greybull River southwest of the town of Burlington.

The Greybull River Valley has a history of droughts and unreliable irrigation water supply (Table I). As recently as 1989, Greybull Valley growers experienced a drought year with only 4.71 inches of precipitation (67% of average) and suffered losses of over 50 percent of irrigated beets, beans, and barley in the lower valley. Additionally, variability in snowpack in the mountain headwaters (reflected in Greybull River streamflow) is a major factor in irrigation water shortages.

Table I. Streamflow and Precipitation Data for the Greybull River Valley from Selected Years with Significant Shortages in Irrigation Water

Year	Greybull River at Meeteetse Streamflow (AF/yr)	Streamflow % of Average	Sunshine Precipitation (inches)	Sunshine Precipitation % of Average	Greybull Precipitation (inches)	Greybull Precipitation % of Average
1955	109,270	45.3	NA	NA	7.25	103.3
1960	129,140	53.6	NA	NA	5.46	77.8
1977	155,878[1]	64.6	11.97	82.50	6.43	91.6
1988	147,553[1]	61.2	7.73	53.30	7.78	110.9
1989	142,289[1]	59.0	12.41	85.50	4.71	67.1
Mean	114,022		7.37		5.27	

1 Streamflow for these years is estimated because winter flows were not gaged at the Greybull River at Meeteetse station after 1971.

The GVID currently provides irrigation water to its members to supplement natural flows through operation of Upper and Lower Sunshine reservoirs, off-stream storage facilities located approximately 35 miles upstream of the diversions for the Farmers and Bench canals. Construction of these reservoirs improved water availability, particularly during droughts. However, despite their operation, consistent irrigation shortages still occur during spring and fall (Figure I). The shortages contribute to the decision by many farmers to grow less water-sensitive crops and only irrigate a portion of water-righted acres in the District.

It is difficult for the GVID to efficiently manage irrigation water releases within the existing system. Daily variations in snowmelt, precipitation, and return flows from upstream diversions cause extreme fluctuations in diurnal flow in the Greybull River at the diversion to the Farmers and Bench canals. Daily flow variation can commonly exceed 400 to 500 cfs during the irrigation season (Figure II). In addition, it is estimated that water released from existing storage takes, on average, 20 to 22 hours to travel downriver to the major diversion points. The extreme river fluctuations, combined with the time required for releases to arrive at irrigation diversion points, make it difficult to coordinate upstream releases with downstream needs. As a result, a significant amount of water released from storage can go unutilized during the course of the irrigation season.

Figure I. Demand and Supply Curves Illustrating Average Irrigation Shortages For Irrigated Lands below Farmers and Bench Canal Diversion

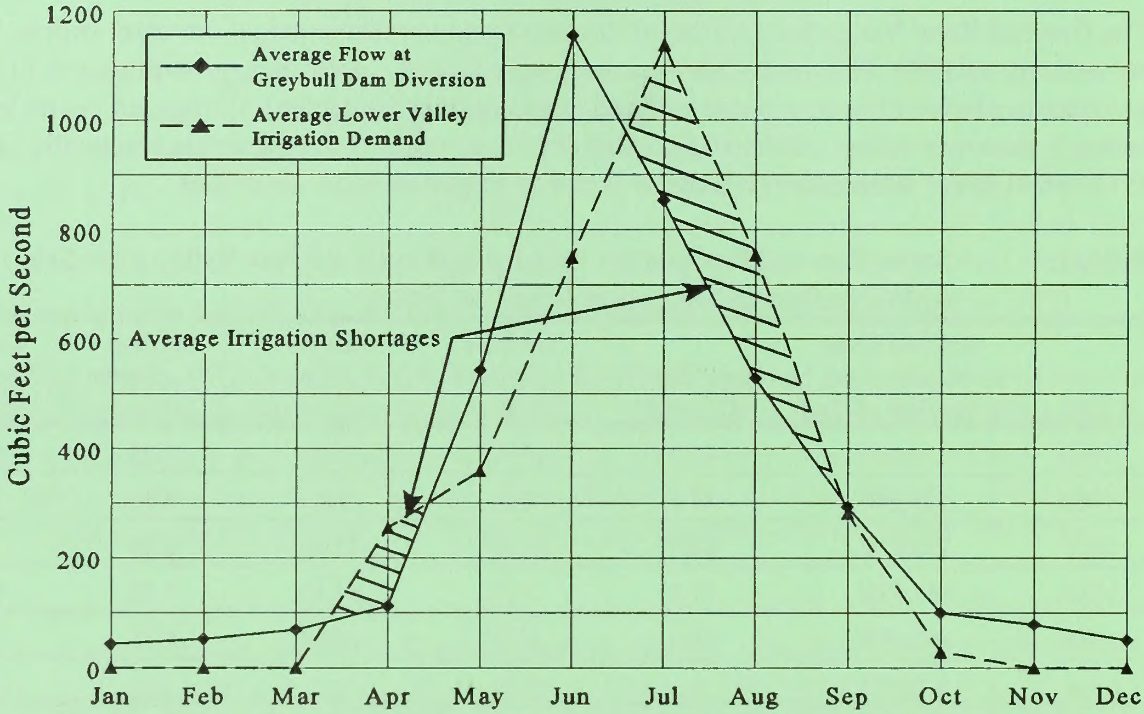
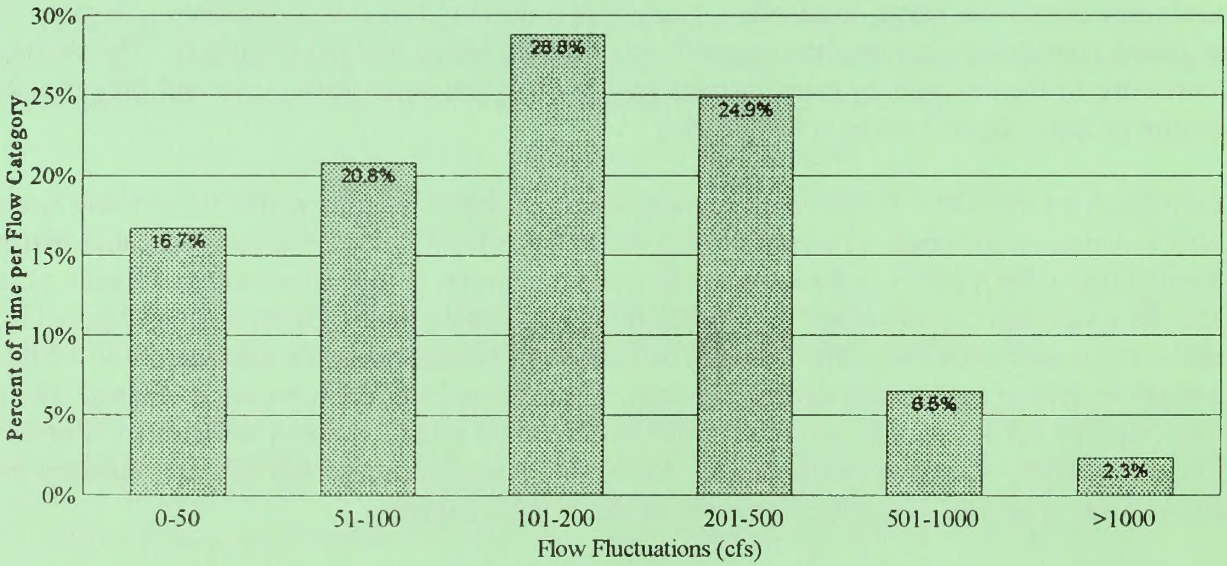


Figure II. Daily Flow Variations Expressed as a Percentage of Total Time In Flow Categories During the Irrigation Season



PUBLIC INVOLVEMENT AND ISSUES

The scoping process for the EIS included public and agency involvement. Issues identified include:

- Land Features
  - soil conditions
  - geologic structures
- Water Resources
  - water quality
  - wetland and riparian areas
  - water management
  - stream flow changes
  - supplemental irrigation water
  - conservation and groundwater
- Air Quality
- Noise
- Biological Resources
  - threatened & endangered species
  - species of special interest
  - aquatic species
  - terrestrial species
- Cultural and Paleontological Resources
- Recreational Resources
- Visual/aesthetics
- Private Property
- Dam Safety
- Socioeconomic
  - long term economic benefits
  - construction workforce
  - housing
  - community concerns
  - hydropower generation feasibility
- Process
  - permitting
  - reasonable and feasible alternatives
- Purpose & Need
- Design
  - single or multiple-use facility
  - off-channel vs. mainstem reservoir
  - delivery canal
  - road improvements
- Rights-of-way
  - GVID land purchase
  - utility ROWs

REQUIRED PERMITS AND APPROVALS

Construction and operation of the proposed dam and reservoir would require a permit from the Corps pursuant to Section 404 of the Clean Water Act and a ROW from the BLM pursuant to Section 5 of the Federal Land Policy and Management Act. The EIS provides the basis for regulatory review and approval for the permit and ROW. The document also provides information for local and state agencies having jurisdictional responsibility for affected resources. Agencies required to provide approval include the Wyoming State Engineer's Office for appropriation of surface water and dam safety certification; Wyoming Department of Environmental Quality for a pollution discharge permit, water quality certification, solid waste disposal, and air quality impacts permit; Wyoming Department of Transportation for a ROW access permit, and Bighorn County for a conditional use permit.

ALTERNATIVE DEVELOPMENT AND EVALUATION

The GVID commissioned a reconnaissance level study of alternative reservoir sites in the lower valley in the late 1980s resulting in the identification and evaluation of 12 potential sites. These previously identified alternatives, along with other possible approaches, were used to arrive at a range of reasonable alternatives for use in the NEPA process. The potential alternatives were as follows:

Blackstone Gulch Reservoir - An off-channel dam and reservoir at the mouth of Blackstone Gulch with storage water delivered from the lower Greybull River via a diversion dam and a 2-mile-long delivery system which includes a 1-mile-long tunnel.

Conservation Program - Reduce irrigation system water loss by lining approximately 100 miles of irrigation canals with concrete.

Groundwater Development - Developing wells and a collection and delivery system to pump groundwater for irrigation use within the irrigation district service area.

Lower Roach Gulch (the applicant's proposal) - An off-channel dam and reservoir at the mouth of an unnamed gulch west of Roach Gulch with storage water delivered from the Lower Greybull River via a diversion dam and 5-mile-long delivery canal.

Lower Sunshine Reservoir Enlargement - Modification to the existing dam and reservoir, construction of a new diversion dam on the Upper Greybull River, and a new delivery canal to increase water storage and delivery capacity.

Mainstem Reservoir Site A - A dam and reservoir on the lower Greybull River about 5 miles upstream from the diversion for Farmers and Bench canals.

Mainstem Reservoir Site B - A dam and reservoir on the Greybull River within a mile upstream of the Town of Meeteetse.

Mainstem Reservoir Site C - A dam and reservoir on the upper Greybull River just downstream of the confluence with both the Wood River and Rawhide Creek.

Mainstem Reservoir Site D - A dam and reservoir on the upper Greybull River downstream of the confluence with the Wood River and above the confluence with Rawhide Creek.

Mainstem Reservoir Site E - A dam and reservoir on the upper Greybull River about 1 mile upstream of the confluence with the Wood River.

Mainstem Reservoir Site F - A dam and reservoir on the Wood River about a mile upstream of its confluence with the Greybull River.

Rawhide Creek Reservoir - An off-channel dam and reservoir on Rawhide Creek with storage water delivered to the reservoir by a 7.3-mile-long canal from a new diversion dam on the upper Greybull River.

Spring Creek Reservoir - An off-channel dam and reservoir on Spring Creek with storage water delivered to the reservoir via a 16-mile-long canal from a new diversion dam on the upper Greybull River.

Transbasin Diversion from the Shoshone River - A portion of Buffalo Bill Reservoir (Shoshone River) would be used to store water that would be diverted via 47 miles of new canal to the Greybull River upstream of the diversions for the Farmers and Bench canals.

Upper Sunshine Reservoir Enlargement - Modifications to the existing dam, reservoir, diversion dam, and delivery canal to provide increased storage capacity.

No Action - No new actions would be taken to meet project purpose and need.

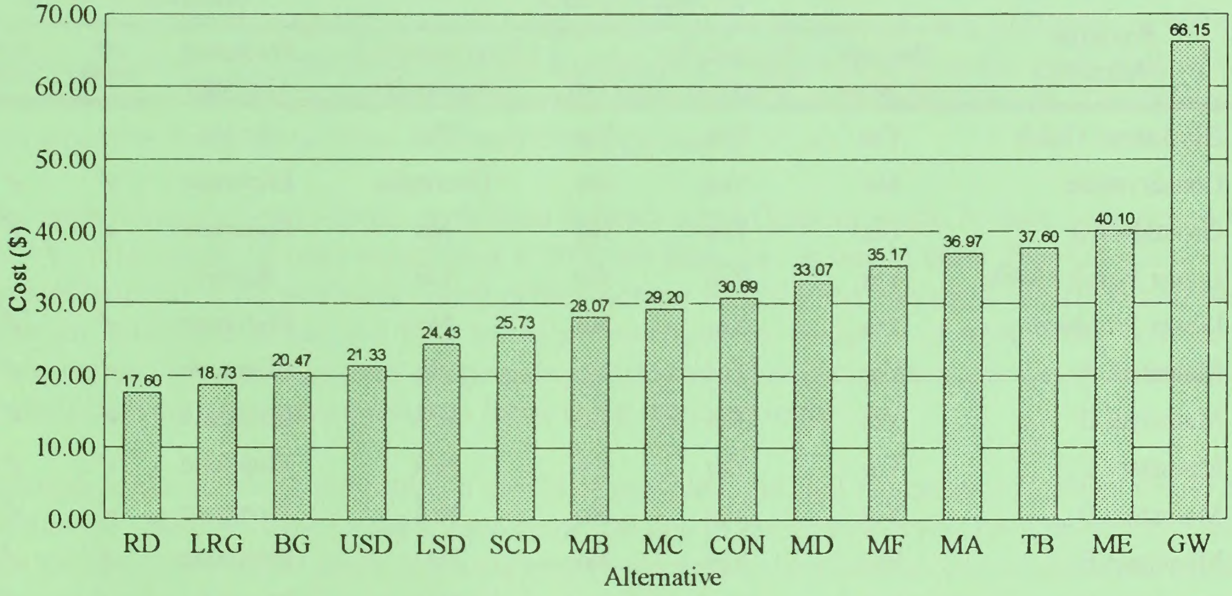
PRESCOPING SCREENING

Two criteria were applied to screen the potential alternatives prior to scoping: (1) the alternative's effectiveness in achieving the public's purpose for the project; and, (2) whether the alternative is reasonable from an engineering and cost standpoint.

The essential element of purpose applied in screening was the alternative's potential for providing a reliable supplemental water supply. That is, 30,000 acre-feet of supplemental storage to offset current estimated shortages and meet the demand to raise higher value crops.

All alternatives evaluated were considered feasible from the engineering standpoint. Results of a survey of GVID members indicate a steep drop in demand for supplemental irrigation water at prices in excess of $20 per share. The cost screening threshold used - $21.33 per water share - is based on approximately what irrigators are willing to pay for supplemental water. A project with a per share cost above $21.33 was not considered economically feasible (Figure III).

Figure III. Per Share Cost by Alternative.



[RD=Rawhide Creek; LRG=Lower Roach Gulch; BG=Blackstone Gulch; USD=Upper Sunshine Dam; LSD=Lower Sunshine Dam; SCD=Spring Creek Dam; MB=Mainstem Dam Site B; MC=Mainstem Dam Site C; CON=Conservation-ditch lining; MD=Mainstem Dam Site D; MF=Mainstem Dam Site F; MA=Mainstem Dam Site A; TB=Transbasin Diversion; ME=Mainstem Dam Site E; GW=Groundwater Wells]

POSTSCOPING ALTERNATIVES EVALUATION AND SCREENING

Postscoping alternatives screening was principally conducted for environmental effects. Field investigations and preliminary effects analyses identified wetlands and other sensitive natural and human resources which may be affected by implementation of each of the potential alternatives.

Of 15 potential action alternatives considered, 13 were eliminated (Table II). The remaining alternatives were Lower Roach Gulch (the applicant's proposal), Blackstone Gulch, and NEPA-required No Action.

ALTERNATIVES SELECTED FOR EFFECTS ANALYSIS

ALTERNATIVE A: NO ACTION

Under this alternative, none of the action alternatives would be approved or constructed. Consideration of this alternative is required by NEPA. There would be no change in the supply of irrigation water and existing shortages would continue. Supplemental irrigation water for the GVID would continue to be stored in, regulated by, and released for delivery from Upper and Lower Sunshine reservoirs. Cropping patterns would not be expected to change. Farmers would continue to experience some risk in planting sugar beets due to unreliable early season water delivery. During dry years, there may not be sufficient water available to prevent crop failure. There would not be sufficient water available to increase the number of acres irrigated under existing water rights.

Table II. Summary of Alternative Screening

Potential Alternative	Screening Criteria[1]				Eliminate or Retain		
	Purpose & Need	Technically Feasible	Cost	Environmental (wetlands)	Screening Decision	pre-scope	post-scope
Blackstone Gulch	Yes	Yes	Yes	Yes	Retain		
Conservation	No	Yes	No	Uncertain	Eliminate	✓	✓
Groundwater	No	Yes	No	No	Eliminate	✓	✓
Lower Roach Gulch	Yes	Yes	Yes	Yes	Retain		
Lower Sunshine	Yes	Yes	No	No	Eliminate	✓	✓
Mainstem A	Yes	Yes	No	No	Eliminate	✓	✓
Mainstem B	Yes	Yes	No	N/A	Eliminate	✓	✓
Mainstem C	Yes	Yes	No	N/A	Eliminate	✓	✓
Mainstem D	Yes	Yes	No	N/A	Eliminate	✓	✓
Mainstem E	Yes	Yes	No	N/A	Eliminate	✓	✓
Mainstem F	Yes	Yes	No	N/A	Eliminate	✓	✓
No Action	N/A	N/A	N/A	N/A	Retain		
Rawhide Creek	Yes	Yes	No	No	Eliminate		✓
Spring Creek	Yes	Yes	No	N/A	Eliminate	✓	✓
Transbasin Diversion	Yes	Yes	No	N/A	Eliminate	✓	✓
Upper Sunshine	Yes	Yes	Yes	No	Eliminate		✓

[1] A yes was assigned when the alternative passed and a no assigned when the alternative failed the criteria.

ALTERNATIVE B: LOWER ROACH GULCH

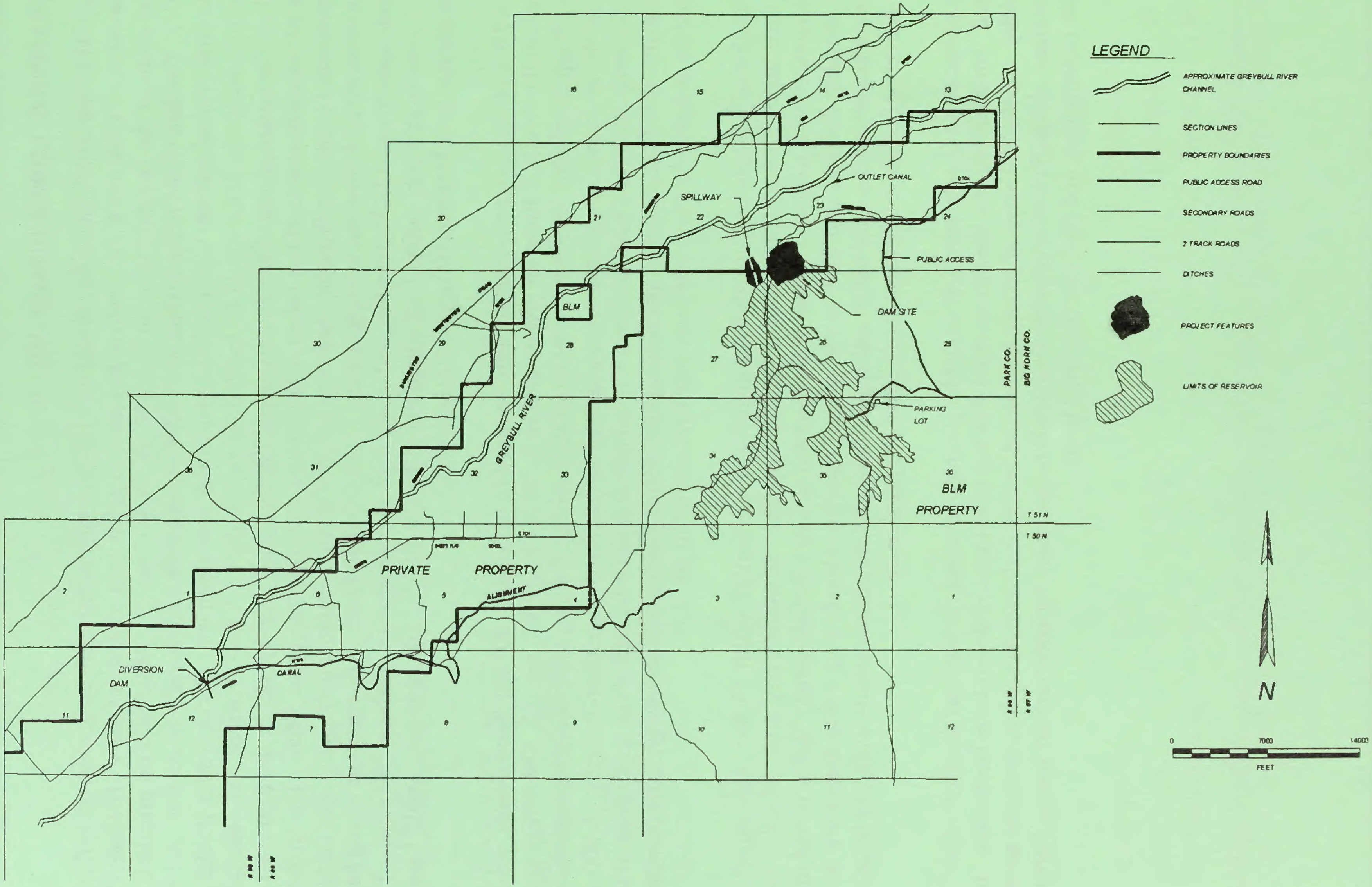
The proposed Lower Roach Gulch dam would be a 150-foot-high zoned-earth embankment dam with a crest elevation of 4,950 feet at the mouth of an unnamed gulch west of Roach Gulch. The dam site is located south of the Greybull River in T. 51 N., R. 98 W., sec 23, SW¼SW¼ on private land (Figure IV). The dam would be approximately 1,720 feet long with a crest width of 25 feet. A 150-foot-wide earth channel spillway would be located near the west abutment. Outlet works, discharge canal, and caretaker facilities would be located below the dam. A low concrete wall would be installed on the upstream top of the dam to extend the freeboard to 6 feet above the dam crest to retain flood waters in excess of the 100-year flood event and wave run-up to 3 feet. The spillway would be designed to pass the Probable Maximum Flood without overtopping the dam. The earthen discharge canal would follow the existing channel to the Greybull River. The reservoir would have a maximum capacity of 33,470 acre-feet with a full pool surface acreage of about 700 acres. The inundated area is primarily public land administered by the BLM. The reservoir would have a minimum storage pool between 800 and 2,500 acre-feet.

A proposed 6-foot-high concrete diversion dam, designed to withstand 100-year flood events, would be located on the Greybull River on private land in T. 50 N., R. 99 W., sec. 12, SW¼NE¼ at an elevation of approximately 5048 feet. A 700-foot-long earthen training dike would be constructed from the north dam abutment upstream encompassing 100 year flood stage river channels. A 800 cfs capacity sluiceway with steel wall liners and a radial gate would be located at the south edge of the diversion dam. The diversion canal intake would be located south of the sluiceway. The diversion dam would be designed to allow minimum flow bypasses of 50 cfs.

The approximately 5-mile-long, earth-lined delivery canal (bottom width 15 feet, side slopes of 2H:1V, total depth 12 feet) would have a 1000 cfs capacity. It would carry diverted water to a terminal structure at the southwest corner of the reservoir at 5,015 feet elevation. Water would then enter an existing drainage and flow to the normal reservoir elevation of 4,946 feet. Four drop structures are included in the canal design and approximately 20 irrigation turnouts would be installed to allow delivery of irrigation water to farms along the canal route.

Although public access to the reservoir would be provided, minimal recreational facilities would be constructed. No plans exist for the state to stock fish due to extreme reservoir level fluctuations and high turbidity. About 200 acres of private land would be acquired for dam construction and access to borrow areas. About 715 acres of public land would be necessary for construction access, borrow areas, dam construction, and reservoir inundated lands.

Figure IV. Map of the Lower Roach Gulch Alternative Project Area Displaying Project Features



The proposed reservoir would be operated in conjunction with the existing Upper and Lower Sunshine reservoirs. Runoff occurring too early in the season for diversion into Upper and Lower Sunshine would be diverted into Lower Roach Gulch Reservoir. As the irrigation season progresses, releases would be made from the Sunshine reservoirs into the Greybull River for diversion into Lower Roach Gulch Reservoir. The Lower Roach Gulch Reservoir diversion structure would also be capable of capturing flows from tributaries downstream of the Sunshine reservoirs diversions as well as peak flows in excess of the Sunshine reservoirs' diversion capacities and flows in excess of downstream irrigation requirements. While upstream diversions for irrigation use would rely upon streamflow and/or releases from the Sunshine reservoirs, irrigation from the Bench and Farmers canals would rely on releases from Lower Roach Gulch and diversion of natural river flows. System operation would result in significant fluctuations in surface acreage and storage pool throughout the year at Lower Roach Gulch Reservoir, depending on stored runoff volume and timing and volume of releases. However, the magnitude of fluctuations in Upper Sunshine Reservoir would be reduced.

ALTERNATIVE C: BLACKSTONE GULCH DAM AND RESERVOIR

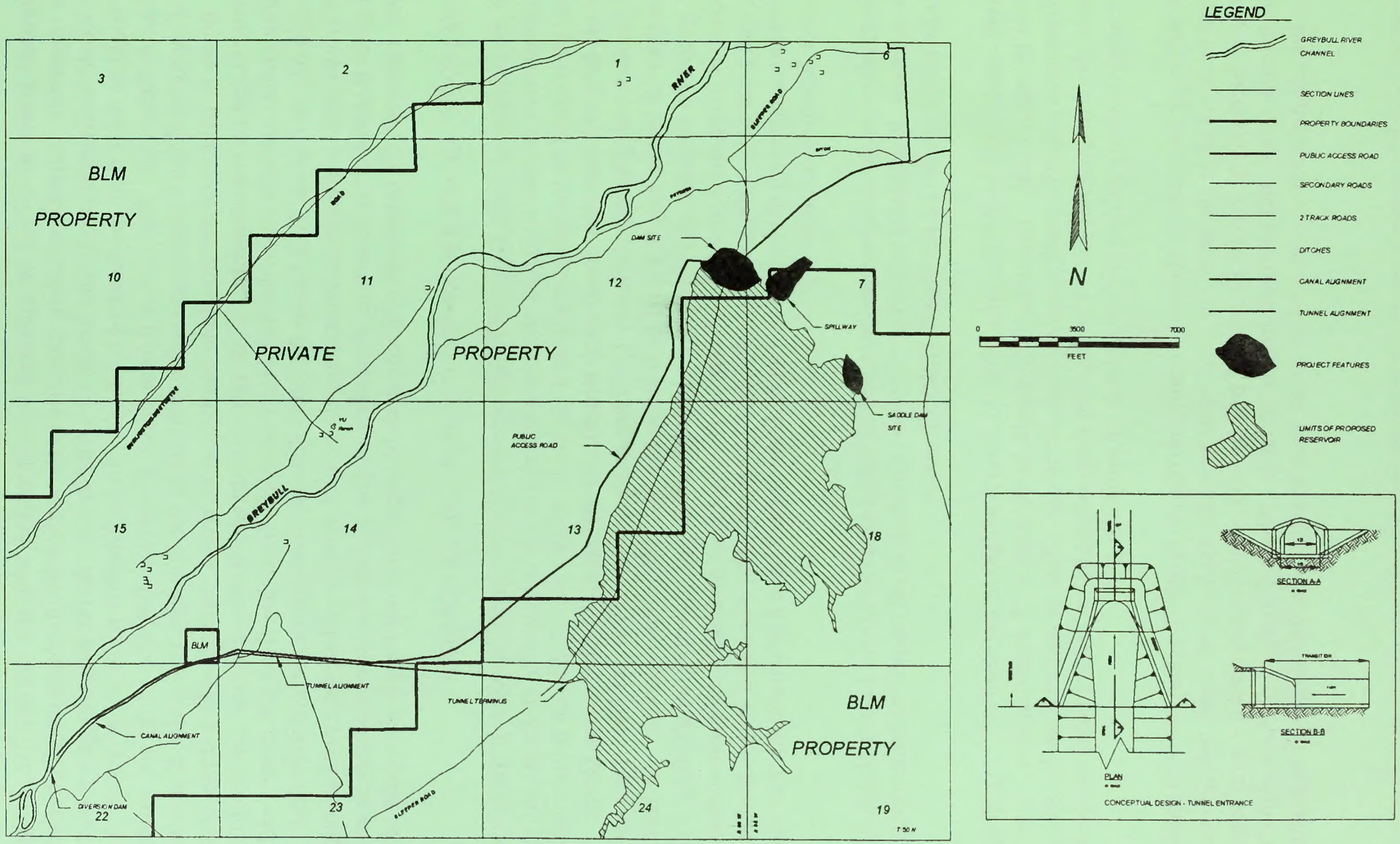
Although the Blackstone Gulch Dam and Reservoir would be located to the west of the Lower Roach Gulch Alternative in another drainage, the two alternatives are very similar in design and operation. Blackstone dam would be located primarily in T. 50 N., R. 99 W., sec. 12, E½ on private land (Figure V). It would be a 115 foot-high, zoned-earth structure at the mouth of Blackstone Gulch. The crest length of the dam would be approximately 1,400 feet at an elevation of 5,190 feet. Two small saddle dikes less than 15 feet in height would be built on the east side of the reservoir. An earth channel spillway would be included and discharge water from the outlets works would flow through the existing channel to the Greybull River. The reservoir would have a capacity of approximately 30,000 acre-feet with a full pool surface acreage of about 700 acres. The inundated area is primarily public land under the management of the BLM. The reservoir would have a minimum storage pool similar to the Lower Roach Gulch Reservoir.

The diversion dam design and construction would be identical to the Lower Roach Gulch Alternative diversion structure. It would be located on the lower Greybull River on private lands approximately 2 miles upstream from the Lower Roach Gulch diversion.

The delivery canal would be 2 miles long from the diversion dam to the reservoir. Approximately 1 mile would be open canal. The other mile would be through a 13-foot-diameter, concrete-lined tunnel. The tunnel would be constructed through sandstone, siltstone, and clay shales and terminate on the west shore of the reservoir. The delivery canal would be on private lands, while the tunnel would be approximately half on private and half on public land.

Although public access would be allowed, minimal recreation facilities would be constructed and no fish would be stocked in the reservoir. No plans exist for the state to stock fish due to extreme reservoir level fluctuations. About 50 acres of private land would be acquired for dam construction, access to borrow areas, and reservoir inundated lands. About 700 acres of public land would be necessary for construction access, borrow areas, dam construction, and reservoir inundated lands.

Figure V. Map of the Blackstone Gulch Alternative Project Area Displaying Project Features.



Operation of the facility would be in conjunction with operation of the existing Upper and Lower Sunshine reservoirs and would be nearly identical to Lower Roach Gulch. As with the Lower Roach Gulch Alternative, a minimum 50 cfs bypass in stream flow would be maintained at the Blackstone Gulch Diversion Dam.

POTENTIAL IMPACTS

Potential impacts of project implementation were evaluated for each alternative for the issues identified during the scoping process. Although potential environmental effects were identified for many resources, the significance of the effects varied and could be greatly reduced through effective conservation practices. Potentially significant impacts identified which require mitigation are identified in Table IV.

Table IV. Potentially significant impacts identified by resources and alternative.

	Alternative		
Impact by Resources	Lower Roach Gulch	Blackstone Gulch	No Action
LAND USE			
LIVESTOCK GRAZING			
Lost AUMs at reservoir site	Loss of ≈1.8% of Tatman Mountain Common Allotment AUMs	Loss of ≈1.3% of Fernandez/ Blu-Jay Allotment AUMs and ≈52.6% of North Blackstone Allotment AUMs	No loss of livestock AUM's
BIOLOGICAL RESOURCES			
WETLANDS			
Impacts at diversion dam and along canal route	≈0.88 acre impacted; new wetlands formed at canal terminus	No wetlands impacted or created	No wetlands impacted
Impacts at reservoir site	≈2.16 acres impacted; new wetlands formed around shoreline	≈0.55 acre impacted; new wetlands formed around shoreline	No wetlands impacted
Impacts along return flow route	≈0.57 acre impacted	≈0.02 acre impacted	No wetlands impacted
Impacts along GR	≈1.15 acres impacted; ≈6.2 river-miles between diversion and return flow	≈1.46 acres impacted; ≈3.9 river-miles between diversion and return flow	No wetlands impacted
Other wetland impacts	Net increase in wetlands in valley due to increased irrigation and increase in wetlands along Dry Creek due to increased return flow	Similar impacts as LRG Alternative	No wetlands impacted
VEGETATION			

Impact by Resources	Alternative: Lower Roach Gulch	Alternative: Blackstone Gulch	Alternative: No Action
Impact to plant communities	Loss of ≈551 acres of mixed grassland-sagebrush shrubland, ≈19 acres mixed riparian shrub-shrub steppe, ≈105 acres rocky outcrops; impacts to ≈1,025 acres mixed grassland-sagebrush shrubland; ≈1,400 acres of idle land irrigated	Loss of ≈680 acres of mixed grassland-sagebrush shrubland, ≈16 acres mixed riparian shrub-shrub steppe, ≈34 acres rocky outcrops; impacts to similar acres mixed grassland-sagebrush shrubland; ≈1,400 acres of idle land irrigated	No impacts to plant communities
AQUATIC RESOURCES			
Impacts to fish	Diversion structure could block passage of fish; altered flows would slightly degrade aquatic habitat	Similar impacts as LRG Alternative	No impacts to fish
SOCIOECONOMICS			
LOCAL INFRASTRUCTURE			
Impacts to housing	Temporary housing needed for ≈81 households during first year and ≈114 households during the second year	Temporary housing needed for ≈90 households during first year and ≈125 household during the second year	No increased demands for housing
Law enforcement demand	One deputy in Big Horn County needed	Similar impacts as LRG Alternative	No increased need for law enforcement
Emergency medical services	Increased demand for emergency medical services	Similar impacts as LRG Alternative	No increased need for emergency medical services
CULTURAL & PALEONTOLOGICAL RESOURCES			
Impacts to cultural sites	Potential impacts at two sites potentially eligible for nomination to the National Register of Historical Sites	No impacts anticipated	No impacts to cultural resources
Impacts to paleontological resources	Impacts to surface fossils in Willwood Formation	Impacts to surface and subsurface fossils in Willwood Formation	No impacts to paleontological resources

MITIGATION

The two action alternatives evaluated, Lower Roach Gulch and Blackstone Gulch reservoirs, are similar in size and location. Many of the environmental consequences of implementation of either alternative are similar. Many of the impacts are temporary and insignificant.

Some of the measures proposed require best management practices for protecting resources. For example, proper use of water spreaders and erosion control measures at construction sites would

decrease air quality impacts and sediment laden runoff from entering the Greybull River. A storm water management plan would be in place before construction begins to prevent storm water impacts and a maintenance of contaminants spill plan and response kit would be available on site. Operation of sluice gates at the diversion dam to discharge sediment build up should be conducted during periods of high river flows when sediment loading is high. Construction within 0.5 mile of active raptor nests should not occur during the nesting season to prevent disturbance.

Mitigation for impacts to plant communities center around successful reclamation (revegetation) of disturbed areas. A detailed site specific reclamation plan would be drafted and followed to successfully restore disturbed areas to their former state. Impacts to plant and wildlife communities may be further reduced by minimizing impact to habitat adjacent to construction areas.

Altered Greybull River flows are expected to cause some adverse impacts to the aquatic ecosystem. Providing fish passage at the diversion dam during high flow and establishing minimum bypass flows to prevent dewatering of the river below the diversion dam would mitigate these impacts.

There is the potential for wetland impacts to occur in four locations: along the diversion canal, in the area that would be inundated (reservoir site), along the return flow route, and along the river between the diversion and return flow. Wetland impacts which cannot be avoided or minimized would be mitigated by replacing the functions and values of affected wetlands. Creation of in-kind on-site wetlands would be used for mitigating wetland losses.

Socioeconomic impacts are anticipated to housing, law enforcement, and health care. To mitigate housing impacts, temporary housing on site could be provided by the contractor or lease arrangements could be used to provide housing at campgrounds or motels to construction workers. Increased law enforcement demands would be met with an additional Big Horn County deputy or security personnel hired by the contractor. For health care impacts, the contractor should maintain an emergency medical response plan on site for construction related injuries and subsidize local fire and ambulance services to respond to accidents on site.

To mitigate impacts to cultural resources, evaluative testing would be conducted at sites eligible for nomination to the National Register of Historic Places. Depending on results of the testing further mitigation in the form of recovery (excavation) of buried cultural remains could be required. Impacts to paleontological resources would be mitigated through surveys of effected areas, salvage and recovery of identified fossils, and monitoring of construction activity.

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CHAPTER 1.0 PURPOSE AND NEED

1.1 INTRODUCTION

The Greybull Valley Irrigation District (GVID) proposes construction of an off-channel dam and reservoir in Park County, Wyoming. The GVID supplies irrigation water to farmers irrigating land in the lower Greybull River Valley within the north central Bighorn Basin. The GVID has applied to the U.S. Army Corps of Engineers (Corps) for a permit, pursuant to Section 404 of the Clean Water Act (CWA), to discharge dredge or fill materials into waters of the United States. The GVID has also submitted a right-of-way (ROW) application for the proposed project to the United States Department of Interior, Bureau of Land Management (BLM) pursuant to Section 5 of the Federal Land Policy and Management Act (1976) and implementing regulations 43 CFR, part 2800.

The GVID's proposal includes a zoned earth embankment dam at the lower end of an unnamed gulch (an ephemeral tributary of the Greybull River) west of Roach Gulch (Figure 1.1). Water for the reservoir is to be diverted from the Greybull River and delivered to the reservoir via a 5-mile-long supply canal. Water will be released from the dam back into the Greybull River through the existing channel armored to prevent erosion. The proposal includes a minimum or sediment storage pool within the reservoir of approximately 2,500 acre-feet. The project would result in a change in the existing use of 200 acres of private land and 715 acres of public land. At the normal high-water line, the proposed reservoir would store a total of 33,470 acre-feet, inundating approximately 700 acres.

The BLM and Corps determined that an analysis of the environmental effects of the project and reasonable alternatives was necessary to aid in decision making. This Draft Environmental Impact Statement (EIS) was prepared in accordance with the National Environmental Policy Act of 1969 (NEPA) as amended and provides a complete and objective analysis of environmental effects.

1.2 PURPOSE FOR THE PROPOSED ACTION

The GVID's purpose for the proposed dam and reservoir is to provide the lower Greybull Valley agricultural community with supplemental irrigation water by:

- increasing water yield of the system during drought years and periods,
- increasing efficient use of diverted and stored water to avoid waste, and
- providing timely delivery of water to irrigators.

It is anticipated that the supplemental water will be used to irrigate existing and previously tilled but presently idle acreage (with existing water rights) from the confluence of the Wood and Greybull rivers downstream to the mouth of the Greybull River. To accomplish this purpose, the GVID estimates the reservoir should provide approximately 30,000 acre-feet of storage. The project purpose from the public's perspective is to provide a reliable supplemental irrigation water supply for the lower Greybull Valley agricultural community.

1.3 NEED FOR THE PROPOSED ACTION

The lower Greybull Valley is within the north central Bighorn Basin. This area is one of the most arid in Wyoming, averaging approximately 8" of precipitation each year (Roberts 1989), most in the form of late spring snow and rain storms. With the exception of grazing, little agriculture would be possible in the Greybull Valley without irrigation.

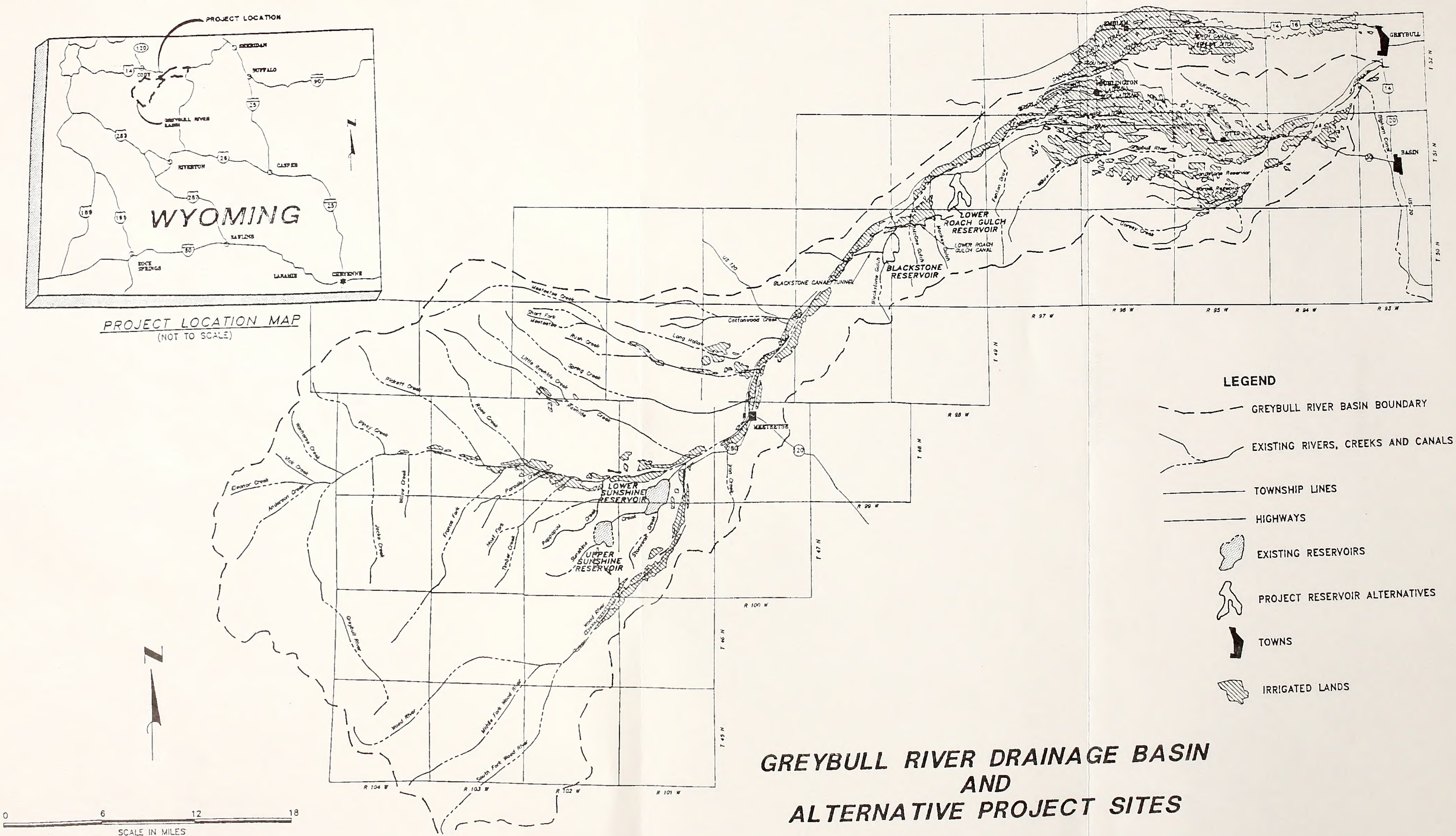
1.3.1 CURRENT IRRIGATION SUPPLIES AND IRRIGATION PRACTICES

Irrigators in the Greybull River Valley have over 88,000 acres permitted for irrigation (Figure 1.1), and currently irrigate approximately 65,000 acres (GEI 1994a). Approximately one-half of the irrigated lands in the GVID (33,500 acres) are served by the Farmers and Bench canals, which divert water from the lower Greybull River southwest of the town of Burlington. Other irrigated lands in the District are served by smaller diversion structures which take water from the upper Greybull River above Meeteetse (5,100 acres), the Wood River (4,600 acres), and the lower Greybull River in the stretch from Meeteetse downstream to Greybull (19,300 acres). No annual inventory is made of the number of acres irrigated within the GVID although the number of irrigated acres apparently varies little from year to year (D. Edwards, GVID, pers. commun.). There have been two complete inventories of irrigated agriculture within the Greybull River Valley. The first was conducted by the Wyoming Water Planning Program in 1971 and identified 65,256 acres irrigated. The second inventory was conducted in 1990 by States West Water Resources Corporation (SWWRC) Cheyenne, Wyoming. The total irrigated acres identified in the SWWRC study was 64,838. The U.S. Geological Survey (USGS) estimated 63,300 acres under irrigation in 1973 (Peterson 1988).

The GVID provides irrigation water to its members through the operation of Upper and Lower Sunshine reservoirs. These reservoirs are off-stream storage facilities located approximately 35 miles upstream of the Farmers Canal and Bench Canal diversions and near the confluence of the Wood and Greybull rivers. The GVID built Upper Sunshine Reservoir in 1939 and Lower Sunshine Reservoir in 1972 to provide supplemental irrigation water to its members. Both projects were funded by the sale of storage shares to GVID members.

All irrigation water in Wyoming is allocated by priority and administered by the Wyoming State Engineer's Office and Board of Control. The majority of the older (territorial) direct-flow priority water rights, approximately 800 cfs, exist in the extreme lower valley near the mouth of the Greybull River. To meet present irrigation demands, these downstream priority water rights, below the diversion point for the proposed reservoir, require a minimum monthly average of 570 cfs during the 7-month irrigation season. If direct-flows and return flows fail to meet water right demands in any month, diversions into upstream reservoirs are not allowed and releases are called for by the individual storage holders at their discretion. During years of above-average moisture conditions, holders of territorial direct-flow priority rights have adequate irrigation water. Most holders of irrigation water rights require water from storage each year.

Figure 1.1 Greybull River Valley drainage and alternative project areas.



1.3.2 CROPS AND CROPPING PATTERNS

Farming practices along the Greybull River vary with elevation and water availability. Alfalfa and native hay crops are commonly grown at higher elevations along the Wood and upper Greybull rivers and in areas where the supply of water for irrigation is unpredictable. However, in farm areas below approximately 5,100 feet in elevation, cash crops such as small grains, dry beans, and sugar beets are more common.

Based on responses to a survey of 111 GVID members served by the Farmers and Bench canals, GEI (1994a) estimated the following cropping pattern for a typical farming operation.

Malt barley	33 %
Sugar beets	22 %
Dry Beans	22 %
Alfalfa	17 %

Sugar beets are grown under contract to sugar companies with processing plants in the area. Currently, Holly Sugar Company has capacity to process additional sugar beets in the Bighorn Basin (D. Mischke, Holly Sugar Company, pers. commun.), but Western Sugar Company does not. Holly Sugar Company would like to expand their existing processing facility and would like to have an additional 4,000 to 5,000 acres of sugar beets in the valley.

1.3.3 CROP WATER REQUIREMENTS

Water requirements are different for each crop (Table 1.1). While alfalfa and malt barley crops require irrigation in the Greybull Valley, these crops are less susceptible than beans and sugar beets to variations in the supply and timing of irrigation water (Cochran et al. 1992). Sugar beet plants on average require water from April through September in the project area. To insure final emergence, spring water requirements are high (Hagan et al. 1967, Fornstrom et al. 1978). In the Powell, Wyoming area, final emergence of sugar beets is dictated by the lowest soil moisture reading during the emergence period; a final emergence of over 60 percent may require a soil moisture content above 10.5 percent (Fornstrom et al. 1978).

Hagan et al. (1967; page 647) reported that rainfall and irrigation should be adequate to bring the entire soil profile to field capacity (that is, the maximum amount of moisture the soil profile can hold) early in the growing season to insure best germination of beets. Beets can withstand considerable water stress during periods of growth but the last watering is critical to the production of a quality beet crop (W. Smith, University of Wyoming Agricultural Field Station, pers. commun.). A lack of fall water reduces the sugar content, and thus the value of beets.

Dry beans require irrigation from June through September in all but the wettest years (Pochop et al. 1992). Beans must receive water on a regular basis and a delay of even a few days can result in as much as a 50 percent crop loss (W. Smith, University of Wyoming Agricultural Field Station, pers.

commun.). However, beans are very sensitive to over-irrigation (Cochran et al 1992), and too much water will cause root rot.

Table 1.1 Average annual consumptive irrigation and diversion requirements for the Greybull Valley Irrigation District and existing supplies and shortages based on the analysis of supply and demand for the period 1945 to 1989.

Average Irrigation Requirements (AF)[1]

Crop	April	May	June	July	Aug	Sept	Oct	Total
Sugar Beets	2,947	1,364	3,982	8,322	7,436	3,614	0	27,665
Beans	0	0	1,533	7,845	6,550	687	0	16,615
Malt Barley	145	4,612	8,318	7,503	0	0	0	20,578
Alfalfa	1,888	3,120	3,932	5,557	4,494	2,200	596	21,807
Total	4,980	9,096	12,765	29,227	18,480	6,521	596	86,664

Average Diversion Requirements (AF)[2]

Crop	April	May	June	July	Aug	Sept	Oct	Total
Sugar Beets	6,180	2,860	8,351	17,454	15,596	7,579	0	58,020
Beans	0	0	3,2151	16,452	13,738	1,441	0	34,846
Malt Barley	303	9,673	17,444	15,735	0	0	0	43,155
Alfalfa	3,960	6,544	8,247	11,654	9,425	4,656	1,249	45,735
Total	10,443	19,077	37,257	61,295	38,759	13,676	1,249	181,756

Average Existing Supplies (AF)[3]

April	May	June	July	Aug	Sept	Oct	Total
7,168	29,743	64,960	49,382	31,537	19,613	7,644	210,047

Average Annual Shortages (AF)

April	May	June	July	Aug	Sept	Oct	Total
3,275	0	0	11,913	7,222	0	0	22,410

1 Average monthly irrigation requirements for present conditions are based on current cropping patterns from an irrigation survey conducted by GEI (1994a); consumptive use of crops for Powell, Wyoming (Pochop et al. 1992); precipitation data for Emblem, Wyoming (Martner 1986); and calculated additional spring water requirements for sugar beet germination (WEST 1996b).

2 Irrigation efficiencies based on WEST OPSTUDY modeling. Assumes 40% efficiency for upper valley, 43 % efficiency for lower valley, and 50% efficiency for lands under the Farmers and Bench canal system.

3 average monthly flow at the reservoir diversion point is based on flows at the Greybull River near Meeteetse gage adjusted for diversions and return flows occurring below the gage and above the diversion point and assumes existing operation schedule for Upper and Lower Sunshine reservoirs.

1.3.4 PRESENT IRRIGATION SYSTEM EFFICIENCY

It is also difficult for the GVID to efficiently manage irrigation water releases within the existing system. Daily variations in snowmelt, precipitation, other diversions, and return flows between the headwaters and the diversion to the Farmers and Bench canal systems cause extreme fluctuations in diurnal flow in the Greybull River (GEI 1994a). Due to snowmelt and thunderstorms, daily flow variations can commonly exceed 400 to 500 cfs during the irrigation season (Figure 1.2). In addition, the GVID estimates that water released from existing storage takes, on average, 20 to 22 hours to travel the more than 20 miles to the major diversion points. These extreme river fluctuations, combined with the time required for releases to arrive at irrigation diversion points, make it difficult to coordinate upstream releases with downstream diversion needs on a daily basis. As a result, a significant amount of water released from storage can go unutilized during the course of the irrigation season (GEI 1994a). For example, several days lead time is required for water orders. If a rain occurs after water is requested but prior to delivery or if natural flow in the Greybull River increases due to increased snowmelt or rains, water that is no longer required for the crop cannot be re-captured and continues downstream. If delivery of the storage water coincides with low natural flow, it may have to be bypassed to meet downstream requirements. Hourly flow modeling suggest that in excess of 1,200 acre-feet per year may be bypassed due to flow fluctuations, depending on the management of headgates.

It is difficult to account for storage releases and natural flow in operating reservoir diversions. When large natural flow fluctuations occur, it is practically impossible to split the flow in the river into its natural flow and storage components at the diversion without extensive, expensive, and usually unreliable real-time monitoring of flow at all critical points in the system. In addition, it is very difficult to operate the diversion to allow bypass of only the natural flow without automatically operated gates that are linked to a system-wide monitoring system. The present system is actually operated such that the gates are set to bypass the amount of flow required to meet downstream prior water rights at all times.

1.3.5 PRESENT AND FUTURE IRRIGATION SHORTAGES

The Greybull River Valley has a history of droughts and unreliable irrigation water supply. Serious droughts occurred in the Bighorn Basin in 1919, 1955, 1960, 1977, 1988, and 1989 (Table 1.2). As recently as 1989, a drought year with 4.71 inches of precipitation at Greybull (67 percent of average), Greybull Valley growers had severe water shortages and suffered the loss of slightly over 50 percent of all irrigated beets, beans, and barley in the lower valley (Edwards 1994). However, because the Bighorn Basin is so dry, precipitation is less a factor in irrigation shortages than snowpack in the mountain headwaters.

Figure 1.2 Daily flow variations expressed as a percentage of total time in flow categories (cfs), during the irrigation season.

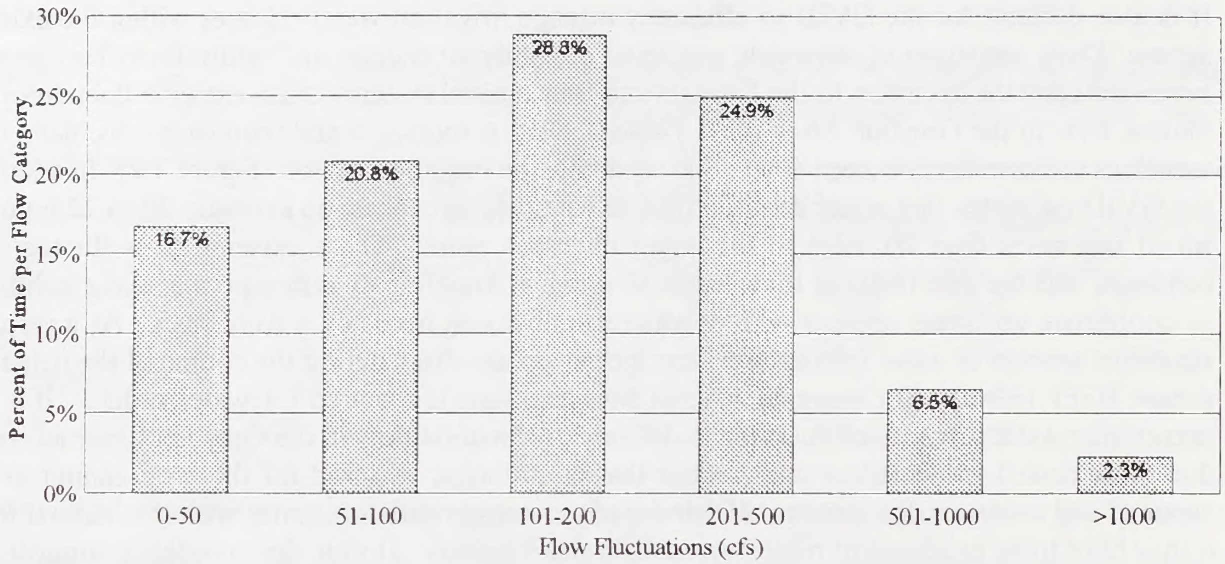


Table 1.2 Streamflow and precipitation data for the Greybull River Valley from selected years with significant shortages in irrigation water.

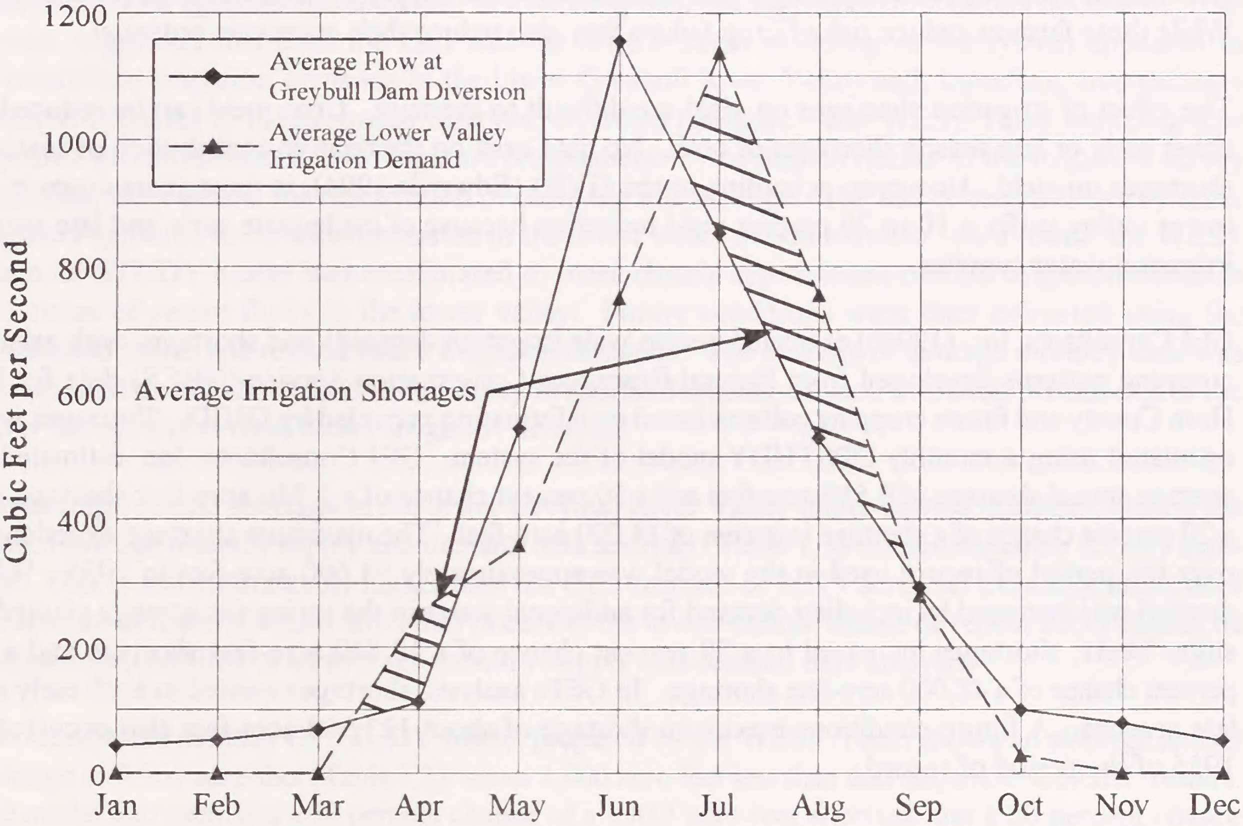
Year[1]	Greybull River at Meeteetse Streamflow (AF/yr)	Streamflow % of Average	Sunshine Precipitation (inches)	Precipitation % of Average	Greybull Precipitation (inches)	Precipitation % of Average
1955	109,270	45.3	NA[3]	NA	7.25	103.3
1960	129,140	53.6	NA[3]	NA	5.46	77.8
1977	155,878[2]	64.6	11.97	82.50	6.43	91.6
1988	147,553[2]	61.2	7.73	53.30	7.78	110.9
1989	142,289[2]	59.0	12.41	85.50	4.71	67.1
Mean[4]	241,084		14.47		6.95	

1 The year of 1919 is known as a very dry year but there is no available data on precipitation or streamflow for that year.
2 Streamflow for these years is estimated because winter flows were not gaged at the Greybull River at Meeteetse station after 1971.
3 NA indicates no data available.
4 Mean for the period of record at each station

Construction of Upper Sunshine Reservoir in 1939 and Lower Sunshine Reservoir in 1972 improved water availability, particularly during droughts. The two reservoirs have a combined storage capacity of nearly 112,000 acre-feet. Upper Sunshine Reservoir stores water diverted from the upper Greybull

River, while Lower Sunshine Reservoir stores water diverted directly from the Wood River and indirectly from the Greybull River via Upper Sunshine Reservoir. Despite construction of these reservoirs, consistent irrigation shortages still occur during spring and late summer (Figure 1.3; Table 1.1). These shortages contribute to the decision by many farmers to produce less water-sensitive crops and to irrigate only a portion of the water-righted acres in the District (GEI 1994a).

Figure 1.3 Demand and supply curves based on data from 1945 to 1989 illustrating average irrigation shortages for irrigated lands below Farmers Canal and Bench Canal Diversion (GEI 1994b).



Early-season water shortages are frequently encountered because the existing reservoirs are located at high elevations where river ice makes irrigation releases impractical during the early part of the growing season in the lower valley. Upper Sunshine Reservoir is located at 6,596 feet and Lower Sunshine Reservoir is located at 6,277 feet. In addition, the head waters of the Greybull and Wood rivers are in the Absaroka Mountains at elevations in excess of 11,000 feet. The elevation of the Farmers Canal and Bench Canal diversions downstream is approximately 5,100 feet.

The Sunshine, Wyoming NOAA weather station is located 2 miles east-northeast of the community of Sunshine on the Wood River and is intermediate in elevation between Upper and Lower Sunshine

reservoirs. Based on data from this weather station, the long-term average April temperature is 37°F and the average minimum temperature is 23°F. The minimum temperature is below freezing for an average of 26.7 out of 30 days in April (Martner 1986). Given these temperatures and the common winter snow cover, freezing problems with the inlet and outlet canals for the two reservoirs are likely. Mr. Charlie Raper (GVID, pers. commun.) indicates that reservoir gates are ready for deliveries each year on April 15th. Although, "ice-out" of the upper reservoirs and the river channels immediately downstream routinely occurs after May 1 and can extend into late May.

Late-season shortages are also common requiring the use of large amounts of stored water when mid-summer and late-summer rains do not occur. These shortages result in periodic crop losses and a selection of crop varieties requiring a less predictable water supply by some farmers (GEI 1994a). While these farmers reduce risk of crop failure they also reduce their economic potential.

The effect of irrigation shortages on yield are difficult to measure. Crop yield can be reduced by either early or late season shortages or both. No data exist on the relative contribution of seasonal shortages on yield. However, according to the GVID (Edwards 1994), in most years crops in the lower valley suffer a 10 to 20 percent yield reduction because of inadequate early and late season irrigation water supplies.

GEI Consultants, Inc. (1994b) estimated system-wide irrigation demands and shortages with existing cropping patterns developed from Natural Resources Conservation Service (NRCS) data for Big Horn County and future cropping patterns based on information provided by GVID. Shortages were estimated using a monthly OPSTUDY model of the system. GEI Consultants, Inc. estimated an average annual shortage of 9,519 acre-feet and a 50 percent chance of a 1,550 acre-feet shortage and a 20 percent chance of a shortage in excess of 14,000 acre-feet. The maximum shortage experienced over the period of record used in the model was approximately 98,600 acre-feet in 1955. When demand was increased by including demand for additional water in the spring for acreage planted to sugar beets, shortages increased to a 50 percent chance of a 10,840 acre-feet shortage and a 20 percent chance of a 48,000 acre-feet shortage. In GEI's analysis, shortages existed in both early and late seasons. A future conditions maximum shortage of about 123,500 acre-feet also occurred in 1955 of the period of record.

To verify GEI's results, the average annual shortage in the system was estimated using cropping patterns obtained from a survey of GVID irrigators (GEI 1994a), independently generated consumptive irrigation and diversion requirements, and average annual streamflow data (WEST 1996b). The resulting average annual estimated shortage of approximately 39,938 acre-feet under existing conditions was substantially higher than GEI estimates.

To resolve these significantly different results, a monthly OPSTUDY model was developed using revised cropping patterns, consumptive irrigation requirements, and diversion requirements (WEST 1996b). A monthly OPSTUDY model results in a more reliable estimate of shortages than the simple comparison of supply and demand by taking into account effects of variable streamflow and return flows. The OPSTUDY model estimated an average annual irrigation shortage in the valley of about

47,500 acre-feet, a 50 percent chance of a 42,000 acre-feet shortage, and a 20 percent chance of a 51,200 acre-feet shortage. Shortages determined using the new model primarily existed during July and August, although shortages of approximately 5,000 acre-feet occurred in April and approximately 3,400 acre-feet occurred in September.

The 50 and 20 percent probability shortages, assuming current and potential future cropping, were substantially higher than GEI estimates. However, a similar pattern of spring (April) and late summer (July and August) shortages in supply (Figure 1.3) occurred in both estimates.

Results of the GEI and the WEST Team modeling were reviewed by the GVID and the cooperating state and federal agencies and discussed at a meeting held during preparation of this document. The review suggested that both the GEI and the WEST Team modeling of the system appeared to overestimate irrigation demands in the lower Greybull River Valley and, therefore, overestimate required bypasses at the proposed reservoir diversion headgate. The WEST Team modeling also appeared to overestimate future irrigation requirements by relying on results of the irrigation survey regarding the demand for reactivation of currently idle acreage. The use of return flows by other irrigators appeared to be underestimated in the lower valley in both models. As a result, the WEST Team OPSTUDY model was recalibrated to more closely approximate current irrigation demands and reuse of return flows in the lower valley. Future conditions were then estimated using the recalibrated model and revised future irrigation demands. The analysis of average monthly data was also updated to include revised lower valley irrigation demands, revised irrigation efficiencies in the lower valley, and revised future irrigation demands.

The average annual shortage in the lower Greybull River Valley under current conditions using the revised average monthly supply and demand data analysis (Table 1.3) is approximately 22,400 acre-feet. This is still substantially higher than the GEI estimate of 9,519 acre-feet primarily because of the amount of reuse of return flows that occurs in the lower valley. Reuse of return flows cannot be adequately quantified in an average monthly supply and demand data analysis.

The recalibrated monthly OPSTUDY model prepared by the WEST Team shows an average annual shortage of 8,561 acre-feet (Table 1.3), about 1,000 acre-feet less than that shown in the GEI results. The model also estimates a 50 percent chance of a 1,837 acre-feet shortage and a 20 percent chance of a shortage of 10,618 acre-feet. The difference in results from the GEI model is due to the reduction in irrigation demands and an increase in estimated irrigation efficiency. The maximum shortage over the period of record used in the model remains very high, approximately 90,200 acre-feet in the year 1955.

The need for supplemental irrigation in the future is a function of climate, total irrigated acres, and cropping patterns. Results of the survey of GVID members (GEI 1994a) indicate that 15.1 percent of farmers served by the Farmers and Bench canals would cultivate previously irrigated but currently idle lands and, thus, increase acreage irrigated if additional supplies were available. Currently only 75 percent (47,782 acres) of lands with water rights in the lower valley (below 5,100 feet elevation) are under irrigation (Wyoming State Board of Control 1988). The lower valley boundary of 5,100

feet elevation was chosen because the climate above this elevation, as illustrated by cropping practices in the area, is not conducive to raising beets and beans.

Table 1.3 Total additional storage required in the lower Greybull River Valley (< 5,100 feet elevation) to meet existing and potential future demands based on average monthly data and data from the WEST OPSTUDY model based on monthly streamflow data for the period 1945-1989.

	April	May	June	July	August	Sept	Oct	Total
Based on Average Monthly Flows[1]								
Average Flow at Reservoir Diversion Point[2]	7,168	29,743	64,960	49,382	31,537	19,613	7,644	210,047
Average Diversion Requirements Under Present Conditions[3]	10,443	19,077	37,257	61,295	38,759	13,676	1,249	181,756
Average Diversion Requirements Under Future Conditions[4]	11,244	16,653	35,173	64,659	44,557	15,137	1,022	188,445
Additional Water Required for Future Crops and Acreage	801	-2,424	-2,084	3,364	5,798	1,461	-227	6,688
Average Monthly Shortages Under Present Conditions	3,275	0	0	11,913	7,222	0	0	22,410
Average Total Additional Water Required	4,076	-2,424	-2,084	15,277	13,020	1,461	-227	29,098
Based on WEST OPSTUDY Modeling[5]								
Average Total Additional Water Required Under Present Conditions	20	341	5	1,881	3,168	2,970	176	8,561
Additional Water Required for Future Crops and Acreage	0	65	12	175	451	553	50	1,306
Average Total Additional Water Required for future Conditions	20	406	17	2,056	3,619	3,523	226	9,867

1 Quantities are based on average monthly flows and diversion requirements

2 Average monthly flow at the reservoir diversion point is based on flows at the Greybull River near Meeteetse gage adjusted for diversions and return flows occurring below the gage and above the diversion point under present operation schedules for Upper and Lower Sunshine reservoirs.

3 Average monthly diversion requirements for present conditions are based on current cropping patterns from a survey of irrigators conducted by GEI (1994a); consumptive use of crops for Powell, Wyoming (Pochop et al. 1992); precipitation data for Emblem, Wyoming (Martner 1986); calculated additional spring water requirements for sugar beet germination (WEST 1996b); and irrigation efficiencies estimated during modeling.

4 Average monthly diversion requirements for future conditions are based on estimated changes in cropping patterns based on an irrigation survey conducted by GEI (1994a) and estimated reactivation of idle acreage based on results of sales of shares in the proposed reservoir.

5 Quantities shown are based on monthly modeling of the Greybull River system using an OPSTUDY model developed by GEI (1994a) with modified input files prepared by the WEST Team and model calibration conducted by the WEST Team.

Results of sales-to-date of shares in the proposed reservoir by the GVID are not consistent with the results of the GEI survey, however. Approximately 20,000 of a total of 26,500 storage shares, at one share per acre-foot of storage, had been reserved by irrigators in the valley as of March of 1996. Irrigators reserving these shares have indicated that the additional storage will be used to provide supplemental supplies to currently irrigated lands. The maximum amount of stored water that could be used to bring currently idle lands into production is therefore 6,500 acre-feet. At an estimated

average diversion requirement of 4.53 acre-feet per acre in the lower valley, the maximum acreage of idle lands that could be put into production using the presently unreserved storage is 1,435 acres. Currently, approximately 47,782 acres are irrigated with water from the Greybull River in the lower valley. Future irrigated acreage in the lower valley was estimated to be 49,217 acres for the purpose of determining future demands if additional supplies become available.

The survey also indicated that 22.6 percent of the respondents would switch to higher value crops if additional water supplies were available. To estimate the future cropping pattern we assumed that 22.6 percent of the current acreage in barley and alfalfa would be converted in equal proportions to beets and beans and that idle acreage put into production would be split evenly between the four major crops. This increase in total irrigated acres and acreage planted to sugar beets results in an average annual need (demand) of approximately 9,900 acre-feet of water (Table 1.4) not satisfied by river flows and storage in the Upper and Lower Sunshine reservoirs (WEST 1996b). The 20 percent chance shortage, or the irrigation demand occurring once in 5 years, resulting from changes in irrigation is approximately 12,550 acre-feet. Finally, an additional 41,000 acre-feet of supply would be required by GVID to meet 100 percent of the demand for irrigation water eight out of ten years.

The total demand for water in the lower Greybull River Valley may not be adequately characterized due to limitations of the modeling process. For instance, the model does not include climatic data so shortages occurring due to icing of the outlets of the upper valley reservoirs are not estimated. The input data for the model were also prepared assuming that the present conservative irrigation practices would be continued in the future. If there is sufficient water available in the future, the tendency of irrigators to conserve their storage water by reducing irrigation of lower value crops may not be as great. As evidenced by the number of storage shares reserved to date, total demand for additional water is substantially greater than the modeled demand.

Also, the estimates for crop conversion and increased acreage are derived from a one time survey of a sample of irrigators and from sales of shares in the proposed reservoir and are therefore subjective. While the sample appears representative (random), estimates would vary if the survey were repeated in different years or with a different sample of landowners. Nevertheless, the process for estimation was objective and the resulting projection of future demand seems reasonable for the following analysis of potential impact.

1.4 PUBLIC INVOLVEMENT AND ISSUES

The scoping process for this EIS included public and agency involvement. Chapter 6 provides additional information on the scoping process, public involvement, and issues identification. Issues include land features, water resources, air quality, noise, biological resources including wetlands, socioeconomic, cultural and paleontological resources, recreation, visual quality, private property, dam safety, purpose and need, process, design, and rights-of-way.

1.4.1 REQUIRED PERMITS AND APPROVALS

Construction and operation of the proposed dam and reservoir action will require a permit from the Corps pursuant to Section 404 of the Clean Water Act to discharge dredge or fill materials into waters of the United States. The project will also require a ROW from the BLM pursuant to Section 5 of the Federal Land Policy and Management Act (1976) and implementing regulations 43 CFR, part 2800. This EIS will provide the basis for regulatory review and approval for the permit and ROW. This document will also provide information for other local, state, and federal agencies and governmental entities having jurisdictional responsibility for affected lands and resources. Permits considered necessary for initiation and completion of the proposed action are contained in Table 1.4.

Table 1.4 Federal, state and local permits likely required for construction of Greybull Dam and Reservoir.

Agency Permit	Approximate Time Requirements[1]
United States Army Corps of Engineers	
Section 404 CWA	60 days
United States Bureau of Land Management	
Right-of-Way	60 days
Wyoming State Engineer's Office	
Application to appropriate surface water	60 days
Construction certification/dam safety review	Life of construction
Permit to construct sedimentation ponds	30 days
Wyoming Department of Environmental Quality	
National Pollutant Discharge Elimination System permit	30 days
Water Quality 401 permit certification	30 days
Mining permit	60 days
Solid waste disposal permit	60 days
Fugitive dust permit	30 days
Burn permit	30 days
Spill prevention control and counter measure permit	30 days
Wyoming Department of Transportation	
Right-of-way access permit	30 days
Bighorn County	
Conditional use permit	60-90 days
Private property	
Rights of access	N/A
Wyoming State Historic Preservation Office	
Compliance	N/A

1 Time requirements are estimates following completion of the NEPA process and assume no delays resulting from appeals.

CHAPTER 2.0 ALTERNATIVES

2.1 INTRODUCTION

The National Environmental Policy Act requires federal decision makers to "study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources." (42 USC 4321 et seq., Sec. 102(2)E). The Council on Environmental Quality implementing regulations elaborate on use of alternatives in the NEPA process. The alternative of "no action" must be included in the analysis; all reasonable alternatives should be considered; the reasons for eliminating potential alternatives from detailed study must be provided; the agency's preferred alternative should be identified, when possible; and appropriate mitigation measures not already included in the proposed action or alternatives should be included (40 CFR Part 1502.14).

The purpose of this Chapter is to describe alternative development, evaluation, and screening that resulted in selection of alternatives for comparative effects analysis, to present the selected alternatives, and to identify potential mitigation measures. Based on the effects analysis presented in this DEIS, the BLM's preferred alternative is the Lower Roach Gulch Alternative, Alternative B, as modified by mitigation described in Chapter 5. The Corps does not identify a preferred alternative at this time.

2.2 ALTERNATIVE DEVELOPMENT AND EVALUATION

The alternative development and evaluation process benefitted from previous efforts to identify and evaluate alternative approaches to providing supplemental irrigation water for the GVID. The 1988 Guidebook for Water Resources Management and Development for the Bighorn and Clarks Fork basins (Guidebook) recognized that periodic water shortages occurred in the Greybull River Valley and suggested several alternatives to increase water supplies (HDR 1988). The GVID commissioned a reconnaissance level study of alternative reservoir sites in the lower valley in the late 1980s resulting in the identification and evaluation of 12 potential sites (Bereman 1989). In 1990, GVID sought assistance from the Wyoming Water Development Commission (WWDC) in development of plans for a new reservoir in the lower Greybull River Valley, the Lower Roach Gulch Dam and Reservoir, to enhance management and delivery of irrigation water. With WWDC assistance, engineering, economic, and hydrological studies were undertaken of the applicant's proposed alternative and other potential alternatives (GEI 1991a, 1991b, 1992, 1994a, 1994b and 1994c).

Due to these earlier activities, a number of potential alternatives had been identified and developed prior to the current process. These previously identified alternatives, along with other possible approaches, were used to arrive at a range of reasonable alternatives for use in the NEPA process based on engineering and cost feasibility. Potential alternatives, including the applicant's proposal and

no action, were evaluated and screened before and after the NEPA scoping process to arrive at a refined list of alternatives for effects analysis.

Potential alternatives included structural and nonstructural alternatives, and off-channel and on-channel storage facilities. Locations of the potential structural alternatives identified prior to scoping are displayed on Figure 2.1. Following is a brief description of the potential alternatives originally considered in the screening process.

Blackstone Gulch Reservoir - An off-channel dam and reservoir at the mouth of Blackstone Gulch with storage water delivered from the lower Greybull River via a diversion dam and a 2-mile-long delivery system which includes a 1-mile-long tunnel.

Conservation Program - Reduce irrigation system water loss by lining approximately 100 miles of irrigation canals with concrete.

Groundwater Development - Developing wells and collection and delivery systems to pump and deliver groundwater for irrigation use from formations adjacent to the Greybull River and within the irrigation district service area.

Lower Roach Gulch Reservoir (the applicant's proposal) - An off-channel dam and reservoir at the mouth of an unnamed gulch immediately west of Roach Gulch with storage water delivered from the Lower Greybull River via a diversion dam and a 5-mile-long delivery canal. *[Note: The name Lower Roach Gulch is assigned to this alternative because it is referred to by this name in most of the previous documents and reports pertaining to the project and this name is in common use locally, within the agencies, and the GVID.]*

Lower Sunshine Reservoir Enlargement - Modification to the existing dam and reservoir and construction of a new diversion dam on the Upper Greybull River and a new delivery canal to provide capability to store and deliver additional water.

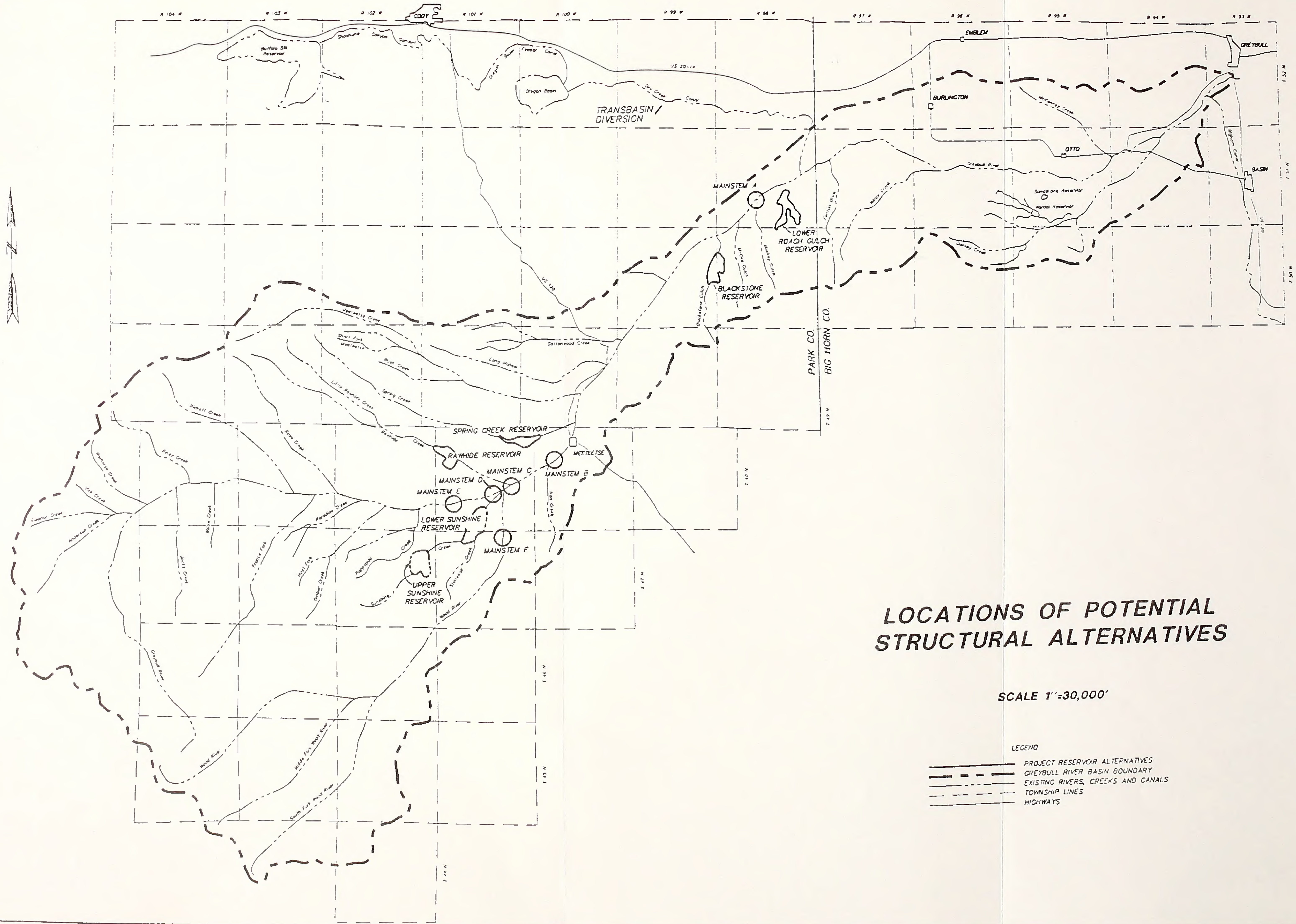
Mainstem Reservoir Site A - A dam and reservoir on the lower Greybull River about 5 miles upstream from the diversion for Farmers and Bench canals. Features include a dam crest length of 5,000 feet.

Mainstem Reservoir Site B - A dam and reservoir on the Greybull River within a mile upstream of the town of Meeteetse.

Mainstem Reservoir Site C - A dam and reservoir on the upper Greybull River just downstream of the confluence of both the Wood River and Rawhide Creek.

Mainstem Reservoir Site D - A dam and reservoir on the upper Greybull River just downstream of the confluence of the Wood River, but above the confluence of Rawhide Creek.

Figure 2.1 Locations of potential structural alternatives.



Mainstem Reservoir Site E - A dam and reservoir on the upper Greybull River about 1 mile upstream of the confluence of the Wood River.

Mainstem Reservoir Site F - A dam and reservoir on the Wood River about a mile upstream of its confluence with the Greybull River.

Rawhide Creek Reservoir - An off-channel dam and reservoir on Rawhide Creek with storage water delivered to the reservoir by a 7.3-mile-long canal from a new diversion dam on the upper Greybull River.

Spring Creek Reservoir - An off-channel dam and reservoir on Spring Creek with storage water delivered to the reservoir via a 16-mile-long canal from a new diversion dam on the upper Greybull River.

Transbasin Diversion from the Shoshone River - A portion of the recently enlarged capacity of Buffalo Bill Reservoir on the Shoshone River would be used to store water that would be diverted from the Shoshone system and carried 47 miles by new canals to the Greybull River just upstream of the Farmers and Bench canals' diversion dam.

Upper Sunshine Reservoir Enlargement - Modifications to the existing dam, reservoir, diversion dam, and delivery canal to provide increased storage capacity and irrigation water delivery.

No Action - No new actions would be taken to meet project purpose and need.

2.2.1 PRESCOPING SCREENING

Screening and evaluation of alternatives to select a final list for effects analysis began prior to the NEPA scoping process and occurred again after scoping. Initial alternatives screening resulted in a short list of preliminarily identified alternatives for discussion and review during scoping.

Two criteria were applied to screen the potential alternatives prior to scoping: (1) the alternative's effectiveness in achieving the public's purpose and need for the project; and, (2) whether the alternative was reasonable from a cost or engineering perspective.

The essential element of purpose and need applied in screening was the alternative's potential for providing a reliable supplemental water supply. Would the alternative provide 30,000 acre-feet of supplemental storage to significantly offset estimated current shortages and meet the demand to raise higher value crops?

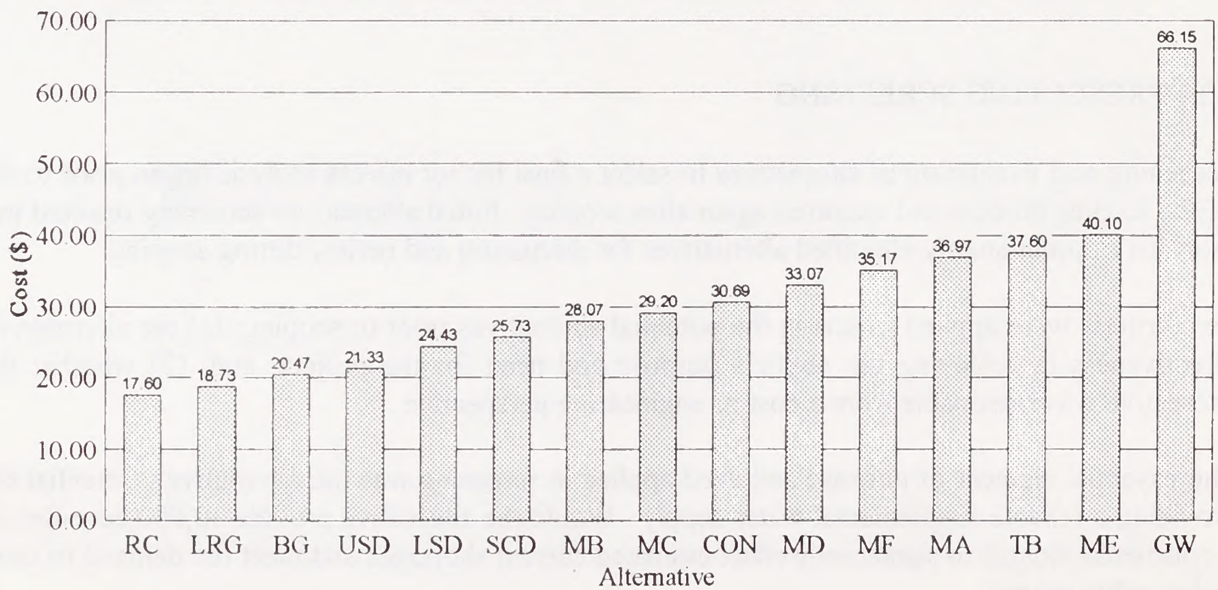
The screening of alternatives to ascertain whether they were reasonable had two parts, engineering feasibility and cost. Screening for engineering feasibility considered whether or not implementation

of the alternative was technically possible. No potential alternative was eliminated due to engineering feasibility. However, when design and engineering encounter problematic site characteristics, achieving technical feasibility can increase cost. Therefore, application of the cost screening factor was an important screening element.

For cost screening, a cost feasibility threshold was established of $21.33 per water share per year. Water shares represent the allocation among GVID water users of supplemental water that would be available through implementation of an action alternative. Irrigators would purchase shares in order to utilize newly available water supplies. The GVID intends to include in the cost of a share the District's portion of project repayment as well as annual operation and maintenance costs. The GVID is responsible for 25 percent of the cost of project construction. A WWDC grant would fund 75 percent of construction costs. For the purpose of comparison, the individual share cost for each structural action alternative is based on the sale of 30,000 shares. For conservation programs and groundwater development alternatives, the individual share cost is based on sale of 11,500 and 11,200 shares respectively.

The cost screening threshold of $21.33 per water share was selected because it is the approximate point (Figure 2.2) where the greatest percentage increase between potential structural alternatives occurs (14.5 percent between Upper and Lower Sunshine reservoirs). This threshold also retains a full range of alternatives to the proposed action. Further, this threshold coincides with a dollar/AF of yield cost screen used for 404(b)(1) analysis that does not include WWDC grant funds. Structural alternatives above this point met purpose and need but are much more costly than those retained.

Figure 2.2 Per share cost by alternative.



[RC=Rawhide Creek; LRG=Lower Roach Gulch; BG=Blackstone Gulch; USD=Upper Sunshine Dam; LSD=Lower Sunshine Dam; SCD=Spring Creek Dam; MB=Mainstem Dam Site B; MC=Mainstem Dam Site C; CON=Conservation-ditch lining; MD=Mainstem Dam Site D; MF=Mainstem Dam Site F; MA=Mainstem Dam Site A; TB=Transbasin Diversion; ME=Mainstem Dam Site E; GW=Groundwater Wells]

The cost screening threshold is similar to what irrigators are apparently willing to pay. The average value of water to GVID irrigators is estimated to be $36.41 per acre-foot. This figure is the break-even point at which the average irrigator would be economically unaffected by purchases of additional water. A price of less than $36.41 is necessary to insure profit incentive for the average irrigator to participate in the project. GVID members were surveyed to estimate the demand for irrigation water at various prices (GEI 1994a). The survey results indicate a steep drop in demand for supplemental irrigation water at prices in excess of $20 per share. It thus appears unlikely that a project with a cost substantially higher than $20 per share for irrigation water would be financially feasible.

These screening criteria were applied to the 16 potential alternatives (Table 2.1). Failure to meet any of the three criterion eliminated an alternative. Two potential alternatives, Conservation Program and Groundwater Development, failed to meet the purpose and need criterion. All potential alternatives were determined to be reasonable based on engineering feasibility. Only four potential alternatives met the screening criterion for cost, with an estimated per share annual cost of $21.33 or less. All but those four action alternatives were eliminated for effects analysis through this screening process. The remaining five alternatives were Blackstone Gulch, Lower Roach Gulch, Rawhide Creek, Upper Sunshine Reservoir, and No Action.

2.2.2 POSTSCOPING ALTERNATIVES EVALUATION AND SCREENING

The five alternatives which met prescoping screening criteria were presented in the public scoping notice. During scoping, representatives of interested state and federal agencies participated in a site visit to the four retained structural alternatives. Public and agency comments received during scoping and identified issues were considered in further refining alternatives for NEPA analysis.

Scoping identified four previously eliminated alternatives for reconsideration. It was requested by the EPA that groundwater development and a conservation program be included as alternatives for effects analysis. Returning Mainstem Reservoir Site A to the list of potential alternatives was considered due to its proximity to diversions for the Farmers and Bench canals and because it was suggested it could provide opportunities for a new sport fishery in the mid-Bighorn Basin. Finally, Lower Sunshine Reservoir enlargement was added back to the list of potential alternatives because its cost per share is only $3.10 over the screening threshold of $21.33 per share. Thus seven alternatives were included in a postscoping alternatives screening process.

The Mainstem Reservoir Dam Site A (GEI 1994a) was eliminated as an alternative for postscoping screening because of cost. The estimated per share construction cost of $36.97 exceeds the cost screening threshold of $21.33 by $15.64. The remaining potential alternatives were screened again to select a final list of alternatives for NEPA analysis. No action (required by NEPA) and the proposed action (Lower Roach Gulch) were retained notwithstanding results of screening. The other potential alternatives included in postscoping screening and a brief description of each follows.

Table 2.1 Application of prescoping screening criteria.

Potential Alternative	Screening Criteria: *Is 30,000 acre-feet storage available?*	*Is Alternative Technically Feasible?*	*Is Cost-per-share $21.33 or less?*	Retain or Eliminate Alternative
Blackstone Gulch	Yes	Yes	Yes - $20.47/share	Retain
Lower Roach Gulch	Yes	Yes	Yes - $18.73/share	Retain
Upper Sunshine	Yes	Yes	Yes - $21.33/share	Retain
Lower Sunshine	Yes	Yes	No - $24.43/share	Eliminate
Mainstem Site A	Yes	Yes	No - $36.97/share	Eliminate
Mainstem Site B	Yes	Yes	No - $28.07/share	Eliminate
Mainstem Site C	Yes	Yes	No - $29.20/share	Eliminate
Mainstem Site D	Yes	Yes	No - $33.07/share	Eliminate
Mainstem Site E	Yes	Yes	No - $40.10/share	Eliminate
Mainstem Site F	Yes	Yes	No - $35.17/share	Eliminate
Rawhide Creek	Yes	Yes	Yes - $17.60/share	Retain
Spring Creek	Yes	Yes	No - $25.73/share	Eliminate
Conservation Program	No[1]	Yes	No - $30.69/share	Eliminate
Groundwater Development	No[2]	Yes	No - $66.15/share	Eliminate
Transbasin Diversion	Yes	Yes	No - $37.60/share	Eliminate
No Action	n/a	n/a	n/a	Retain

[1] Conservation through concrete ditch lining was estimated to achieve a savings of 11,500 acre-feet of water that would be available for use by irrigators. 11,500 acre-feet is less than the 26,000-30,000 acre-feet water yield available from a 30,000 acre-foot water storage facility.

[2] An estimated 11,200 acre-feet of supplemental water supply could be provided from groundwater sources. This is less than the 26,000-30,000 acre-feet water yield available from a 30,000 acre-foot water storage facility.

Blackstone Gulch - a diversion dam and off-channel reservoir similar to the applicant's proposal and located 4.5 miles southwest of the Lower Roach Gulch site. This alternative is described more fully at the end of this chapter.

Rawhide Creek - a dam and reservoir on Rawhide Creek at 6,460 feet elevation with a diversion dam and delivery canal bringing storage water from the Upper Greybull River 7.3 miles away. The dam and reservoir would be located on Rawhide Creek about 3.6 miles upstream from the confluence of the creek and the Greybull River (6th principal meridian, T.48 N., R.101 W., sec. 7, E½). A 150-foot-high, zoned-earth embankment dam with a crest length of approximately 1,500 feet would be required to store 30,000 acre-feet of water. A 3,000-foot-long saddle dike with a maximum crest of 50 feet would be required on the

southern rim of the reservoir. A 200-foot-wide spillway would be constructed on the right abutment of the dam. Releases from the reservoir would be made into Rawhide Creek for delivery into the Greybull River and downstream for diversion into Farmers and Bench canals. Therefore, the Rawhide Creek channel below the dam would have to be stabilized to reduce erosion during higher rates of discharge.

Upper Sunshine Reservoir - Upper Sunshine Dam is an existing zoned-earthfill dam in T. 47 N., R. 102 W., sec. 12 with a spillway elevation of 6,595 feet. The 150-foot-high dam would need to be raised about 23 feet in order to provide additional storage of 30,000 acre-feet. Placement of additional fill on the crest and downstream slope of the dam, removal and reconstruction of the existing saddle dike near the spillway, and construction of a additional saddle dike and 150-foot-wide excavated earth spillway would be required. About 800,000 cubic yards of earthwork would be involved. Modifications would be required to the outlet works at Upper and Lower Sunshine dams to accommodate discharges from the enlarged reservoir and channel improvements would be necessary in Sunshine Creek to handle the increased discharge volume. Also, the Sunshine Diversion Dam on the Upper Greybull River and the delivery canal would need to be enlarged to handle an additional 1,000 cfs. It is believed the upper 5.5 miles of delivery canal could be enlarged to handle 2,000 cfs. The lower 2 miles of canal, however, would have to be replaced to handle the delivery volume and to allow delivery to the higher surface elevation of an enlarged reservoir. Enlargement would probably require draining and loss of use of the existing reservoir for about a year.

Lower Sunshine Reservoir - Lower Sunshine Dam and Reservoir currently stores water diverted from the Upper Greybull River into and through Upper Sunshine Reservoir and water diverted from the Wood River directly into Lower Sunshine. The earthen dam, located in T.48 N., R. 101 W., sec. 28, NE¼SE¼, is approximately 185-feet-high and currently stores 58,748 acre-feet at a normal high-water line elevation of 6,277 feet. There are also two saddle dikes on the left abutment of the reservoir rim with heights of 74 and 40 feet. Enlargement of the reservoir to accommodate an additional 30,000 acre-foot storage would entail raising the dam and saddle dikes 28 feet, filling in the existing spillway and building a new 750-foot-wide spillway, construction of expanded outlet works to handle increased delivery volume, and construction of a new diversion dam on the Upper Greybull River and a delivery canal to convey 1,000 cfs to the enlarged reservoir. An estimated 1.5 million cubic yards of additional materials would need to be added to the crest and downstream slope of the existing embankment and saddle dikes, and a new saddle dike would be added. Rehabilitation of the existing upstream slope with riprap or roller compacted concrete would also be necessary. The reservoir would need to be drained for much of this work and there would be a loss of storage and facility use for approximately a year.

A Wyoming State Engineer's report on 1991 visual inspections of Lower Sunshine Dam recommended maintenance work and monitoring. The minor problems and seepage appeared to be manageable under current conditions. The alternative as described includes some measures to control potential seepage and help assure facility integrity. However, full

technical investigations have not been conducted to fully ascertain the feasibility of increasing storage beyond current capacity.

Conservation Program - There are several options or combinations of approaches for maximizing the use of currently available irrigation water through conservation practices. GVID already experiences some water-use efficiencies by irrigation with return flows and waste water. Other available conservation measures include burying laterals, lining head ditches, conversion to sprinkler irrigation, closer individual management of irrigation, and concrete lining of laterals. Concrete lining of laterals was chosen as a potential alternative because it could be accomplished by the irrigation district as opposed to individual farmers; it is a readily available approach; and its costs and benefits are quantifiable. This potential alternative would involve lining 100 miles of existing delivery laterals with concrete to reduce water loss from seepage. About 20 percent of the water diverted into the Farmers and Bench canals is lost for irrigation use by seepage. It is estimated that lining of laterals could cut that irrigation season loss in half, resulting in the availability of 11,500 acre-feet of retained water.

Groundwater Development - A groundwater development potential alternative was developed for extracting water from the floodplain aquifer which parallels the Greybull River in the lower river valley between the towns of Burlington and Otto. This aquifer was determined to be the most feasible source of groundwater due to its proximity to the project, greater reliability for water production, and lower costs than other groundwater options. This alternative includes drilling 28 water wells, installing pumping equipment, and laying of delivery pipe. Such a system could supplement GVID water by 11,200 acre-feet. However, the aquifer is dependent upon irrigation water for recharge and could not be a reliable source of water until well after irrigation season had begun.

Postscoping alternatives screening was principally conducted for environmental effects. However, purpose and need was also reapplied. For environmental effects, field investigations identified wetland areas and other sensitive natural and human resources which may be affected by implementation of each of the potential alternatives. Although the effects analysis was preliminary, it was believed to be sufficient to estimate the relative potential effects of each of the alternatives to be screened. Potential wetland impacts, in particular, provide a clear differentiation among alternatives and an indication of alternative viability.

The Environmental Protection Agency (EPA) Regulations (40 CFR Ch. 1, Part 230) implementing Section 404(b)(1) of the Clean Water Act provide guidance applicable to alternatives screening for this process. Section 230.10(a) of the regulations describes practical alternatives and the importance of their consideration when there is potential impact on aquatic ecosystems from dredge or fill activities. A proposed action will not be permitted if there is a practicable alternative that would avoid or result in less impacts to aquatic ecosystems, so long as the alternative doesn't have other significant adverse environmental effects.

An alternative is considered practicable if it is available and capable of being completed after taking into consideration cost, existing technology, and logistics in light of overall project purposes. It follows that if a potential alternative has greater impacts to aquatic ecosystems than the proposed action, it lacks viability as an alternative which could be implemented. Therefore, the amount of potentially affected wetland was applied as the single criterion for environmental effects screening. Table 2.2 displays the results of postscoping screening for environmental impacts and the reapplication of the purpose and need screening.

Table 2.2 Application of postscoping screening criteria.

Potential Alternative	Screening Criteria: *Are effects to wetlands[1] greater than proposal's?*	Screening Criteria: *Is 30,000 acre-feet storage available?*	Retain or Eliminate
Lower Roach Gulch	Same - 28.3 wetland acres lost	Yes	Retain
Blackstone Gulch	No - 12.92 wetland acres lost	Yes	Retain
Rawhide Creek	Yes - 64.33 wetland acres lost	Yes	Eliminate
Upper Sunshine Reservoir Enlargement	Yes - 96.44 wetland acres lost	Yes	Eliminate
Lower Sunshine Reservoir Enlargement	Yes - 190.81 wetland acres lost	Yes	Eliminate
Conservation	Yes - >200 wetland acres potentially affected	No	Eliminate
Groundwater Development	Uncertain as to wetland acres affected - impacts to springs, seeps & the water table	No	Eliminate
No Action	n/a	n/a	Retain

[1] Acres of wetlands are based on a reconnaissance level investigation conducted for alternatives screening (WEST 1995b); wetland acres provided in Chapter 4 are based on detailed wetland delineations (WEST 1996c).

Through this screening process, Rawhide Creek, Upper Sunshine Reservoir, Lower Sunshine Reservoir, Conservation and Groundwater Development were eliminated as alternatives for effects analysis. Implementation of each of these potential alternatives could result in substantially greater wetland effects than would implementation of the applicant's proposed action. For Groundwater Development, there would be negative wetland effects, but it is uncertain what quantity of wetland would be affected. However, that potential alternative is not able to meet the federal government's purpose and need of providing an equivalent of 30,000 acre-feet of supplemental water storage, so it was once again eliminated.

Although a specific conservation program (concrete lining of laterals) was eliminated as an alternative, conservation practices could be incorporated into implementation of the remaining alternatives through mitigation measures or permit requirements.

Therefore, of 15 potential action alternatives considered in pre and postscoping screening, 13 were eliminated. The remaining alternatives were two action alternatives, Lower Roach Gulch (the applicant's proposal) and Blackstone Gulch, and NEPA-required No Action. Table 2.3 summarizes results of all screening. Where a potential alternative did not satisfy a screening criterion, "No" is placed in the appropriate column. If the criterion was met, "Yes" is placed in the column. If a screening criterion was not applied, "N/A" (not applicable), is placed in the column. In the columns on the right, the screening decision is stated, retain or eliminate. If an alternative is eliminated, it is indicated whether it was eliminated in prescoping screening, postscoping screening, or both.

Table 2.3 Summary of alternative screening.

	Screening Criteria				Eliminate or Retain		
Potential Alternative	Purpose & Need	Technically Feasible	Cost	Environmental (wetlands)	Screening Decision	pre-scope	post-scope
Blackstone Gulch	Yes	Yes	Yes	Yes	Retain		
Lower Roach Gulch	Yes	Yes	Yes	Yes	Retain		
Upper Sunshine	Yes	Yes	Yes	No	Eliminate		✓
Lower Sunshine	Yes	Yes	No	No	Eliminate	✓	✓
Mainstem A	Yes	Yes	No	No	Eliminate	✓	✓
Mainstem B	Yes	Yes	No	N/A	Eliminate	✓	✓
Mainstem C	Yes	Yes	No	N/A	Eliminate	✓	✓
Mainstem D	Yes	Yes	No	N/A	Eliminate	✓	✓
Mainstem E	Yes	Yes	No	N/A	Eliminate	✓	✓
Mainstem F	Yes	Yes	No	N/A	Eliminate	✓	✓
Rawhide Creek	Yes	Yes	No	No	Eliminate		✓
Spring Creek	Yes	Yes	No	N/A	Eliminate	✓	✓
Conservation	No	Yes	No	Uncertain	Eliminate	✓	✓
Groundwater	No	Yes	No	No	Eliminate	✓	✓
Transbasin Diversion	Yes	Yes	No	N/A	Eliminate	✓	✓
No Action	N/A	N/A	N/A	N/A	Retain		

2.3 ALTERNATIVES SELECTED FOR EFFECTS ANALYSIS

This NEPA process therefore considers as alternatives No Action, Lower Roach Gulch (the applicant's proposal), and Blackstone Gulch.

2.3.1 ALTERNATIVE A: NO ACTION

The project as proposed or alternatives to it would not be approved or constructed. This alternative is required by regulations implementing NEPA. There would be no change under this alternative. The existing shortages in irrigation water would continue. Irrigation water for use by the GVID would continue to be stored in, regulated by, and released for delivery from Upper and Lower Sunshine reservoirs. Cropping patterns would not be expected to change from the status quo. Farmers would continue to experience some risk in planting sugar beets because early season water delivery would be unreliable. During dry years, there may not be sufficient water available to finish out crops. There would not be sufficient water available to increase the proportion of the land irrigated under the existing water rights. However, GVID could make other proposals in the future.

2.3.2 ALTERNATIVE B: LOWER ROACH GULCH

The GVID proposes construction and operation of a diversion dam, delivery canal, and off-channel dam and reservoir to store and manage delivery of Greybull River water for farm irrigation. The project is designed to supplement existing upstream reservoir storage at Upper and Lower Sunshine reservoirs and provide increased reliability and flexibility in managing its water supply.

The proposed Lower Roach Gulch Dam would be a 150-foot-high zoned-earth embankment dam with a crest elevation of 4,950 feet at the mouth of an unamed gulch south of the Greybull River. The dam site is located primarily in T. 51 N., R. 98 W., sec. 23, SW¼SW¼ on private land (Figure 2.3). The dam would be approximately 1,720 feet long with a crest width of 25 feet with a 150-foot-wide earth channel spillway located on the west abutment, outlet works, and discharge canal (GEI 1994b). A low concrete wall would be installed on the upstream top of the dam to extend the freeboard to 6 feet above the dam crest.

The dam would have sufficient freeboard to retain flood waters in excess of the 100-year flood event and wave run-up to 3 feet. The spillway has been designed to pass the Probable Maximum Flood (PMF) without overtopping. The cutoff trench below the dam would extend a maximum depth of 40 feet below grade and a double-line grout curtain would be installed to extend below the cutoff trench. Caretaker facilities would be located below the dam. The earthen discharge canal would follow the existing channel and carry water back to the Greybull River for downstream diversion to the Farmers and Bench canals.

A proposed 6-foot-high concrete diversion dam would be located on the Greybull River on private property in T. 50 N., R. 99 W., sec. 12, SW¼NE¼ at an elevation of approximately 5,048 feet. A 700-foot-long earthen training dike would be constructed from the north dam abutment upstream encompassing 100-year flood stage river channels. A 800 cfs capacity sluiceway with steel wall liners and a radial gate would be located at the south edge of the diversion dam. The diversion dam would be designed and operated to allow minimum flow bypasses of 50 cfs and passage of fish. The diversion canal intake with a 1,000 cfs capacity would be located 54 feet south of the sluiceway and have radial gates. Structures would be designed to withstand a 100-year flood event. Overtopping of the dam in a 100-year flood peak would leave 3 feet of freeboard along the training dike. Fill for the training dike and for delivery canal construction would be obtained from upland, grassland bench borrow areas on public lands and possibly from an agricultural area south of the river on about 60 acres of private lands (Figure 2.3).

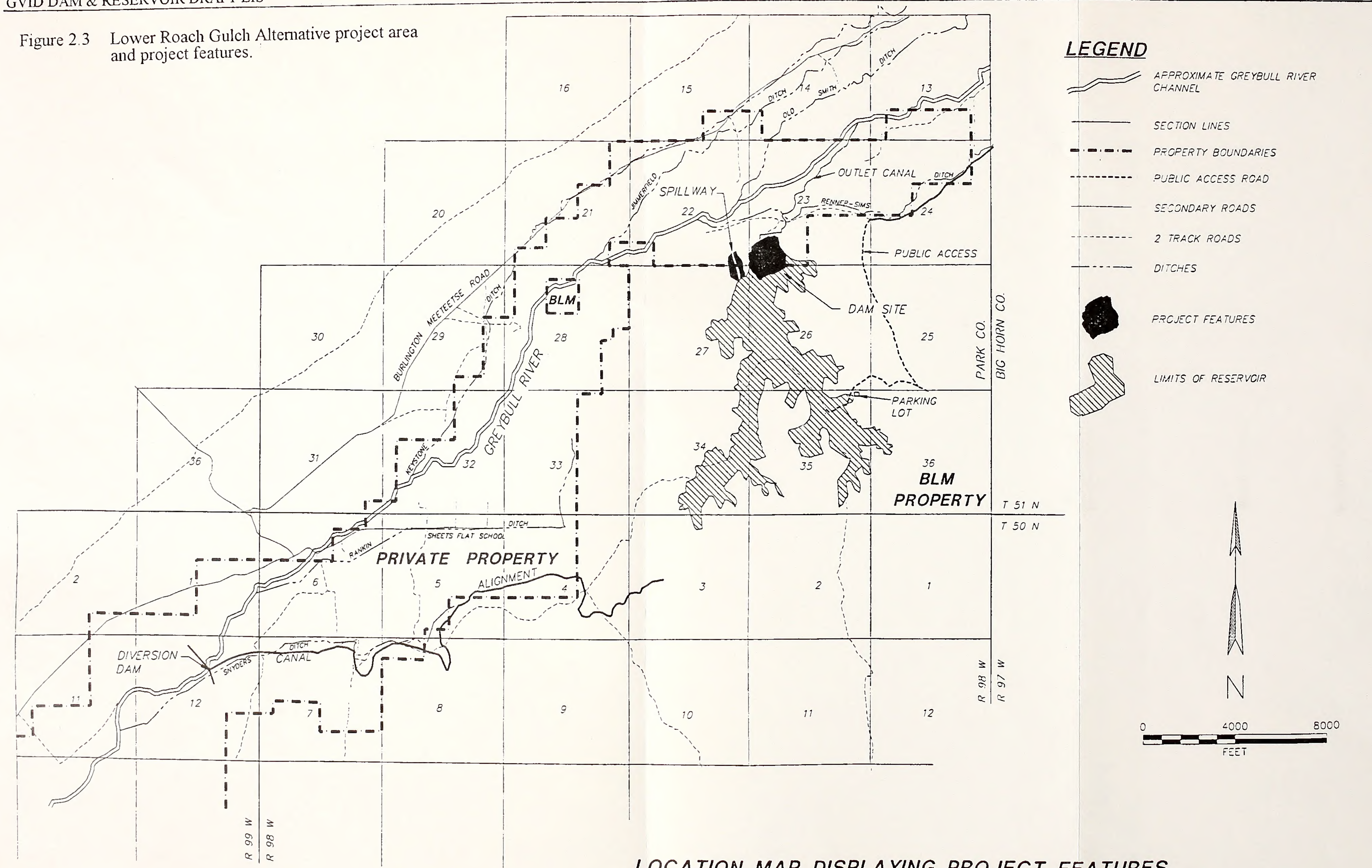
The approximately 5-mile-long, earth-lined delivery canal would have a capacity of 1,000 cfs. It would carry diverted water to a terminal structure above the proposed Lower Roach Gulch Reservoir. The canal's typical bottom width is 15 feet, side slopes of 2H:1V, and a total depth of 12 feet. Four drop structures are included in its design and approximately 20 irrigation turnouts would be installed along its length to allow delivery of irrigation water to farms along the canal's route. The canal would be located at the base of the badlands on the south side of the Greybull River Valley. About 1 mile of canal would be on public lands (33 acres) and the remainder on private lands. The canal would terminate at 5,015 feet elevation where delivery water would enter an existing natural drainage for the last one-half mile drop of 69 feet to the normal reservoir elevation of 4,946 feet.

The delivery canal will cross four drainages: Blackstone Gulch, McGee Gulch, an unnamed gulch, and Mackey Gulch. Each intersection will be designed to capture runoff from the drainage and allow it to enter the canal. With the exception of the Blackstone Gulch crossing, the upper canal bank will create a dam on each of the drainages, thus creating a small detention pond within each gulch. The reservoirs created at McGee Gulch, the unnamed gulch, and Mackey Gulch will encompass approximately 15, 12, and 15 acres respectively. Outlet works would be constructed at each pond to discharge pond outflow to the canal. Overflow spillways would be constructed on the downstream canal berm to prevent damage due to excessive flows. The canal will cross Blackstone Gulch below the canyon and thus does not present an opportunity to create a detention pond. Runoff from Blackstone Gulch will be intercepted at the canal. Overflow spillways will be constructed in the canal to allow harvesting runoff and discharge of excessive flows.

The reservoir created by the dam would have a maximum capacity of 33,470 acre-feet with a full pool surface acreage of about 700 acres. Design calls for a minimum conservation pool storage of 834 acre-feet and a maximum conservation pool storage of 2,500 acre-feet.

Although public access would be provided to the reservoir, minimal recreational facilities are anticipated, and no plans exist for the state to stock fish due to extreme reservoir level fluctuations. About 200 acres of private land would need to be acquired for dam construction and access to

Figure 2.3 Lower Roach Gulch Alternative project area and project features.



LOCATION MAP DISPLAYING PROJECT FEATURES, LOWER ROACH GULCH ALTERNATIVE

Figure 2.7 ... Wash Alternative project area and project features

borrow areas. About 715 acres of public lands would be necessary for construction access, borrow areas, dam construction access, and reservoir inundated lands.

Preliminary wetland investigations conducted by WEST (1995b) indicated that approximately 28.3 acres of wetlands may be effected by implementation of this alternative. Detailed wetland delineations conducted in 1996 (WEST 1996c), however, indicate that there are approximately 4.76 acres of jurisdictional wetlands under CWA potentially effected by this alternative. The majority of these wetlands occur within the area that will be inundated.

Project construction would is not scheduled for completion until 3 years after completion of NEPA analysis and issuance of a Record of Decision (ROD) by the BLM and a 404 permit and ROD by the Corps. Approximately 1 year would be devoted to final design, surveying, mapping, and final design drilling, laboratory testing, and analysis. Actual project construction would take 2 years and would be initiated about 1 year after BLM and Corps approvals, if issued.

Year-round construction would be possible, with storage of water within the new facility planned in early 1999. The total construction site workforce is estimated to be about 150 people; however, the number of people on-site at any one time is uncertain until construction plans are completed.

The reservoir would be operated in conjunction with the existing Upper Sunshine and Lower Sunshine reservoirs as a system. As the irrigation season progresses, and as necessary to afford upper valley reservoir storage capacity or to transfer storage to lower valley delivery, releases would be made from the Sunshine reservoirs into the Greybull River for diversion into Lower Roach Gulch Reservoir. The Lower Roach Gulch Reservoir diversion structure on the Greybull River would also be capable of capturing for storage flows from river system tributaries downstream from the diversions of the Sunshine reservoirs as well as peak flows in excess of the Sunshine reservoirs' diversion capacities. While upstream diversions for farm and ranch irrigation use would rely upon streamflow or releases from the Sunshine reservoirs, irrigation through the Bench and Farmers canals would rely directly on releases from the Lower Roach Gulch and diversions of natural flows in the river. System operation would result in significant fluctuations in surface acreage and storage pool throughout the year at the Lower Roach Gulch Reservoir, dependent upon stored runoff volume and timing and volume of releases.

A detailed description of the present operating plan and a likely plan for future operations with a lower valley reservoir is provided in Appendix A. Typical reservoir operation will primarily involve storage of spring high-flows, with little or no new storage occurring during the winter period, depending upon variations in runoff and Greybull River flows from year-to-year. However, some storage would be delivered downstream to Lower Roach Gulch from the Sunshine reservoirs prior to winter freeze-up of the Greybull River. This fall storage will provide water for early spring release and delivery by call for mid-April sugar beet irrigation. A 50 cfs in-stream flow bypass will be maintained at the diversion dam (Zaft and Annear 1992).

It is anticipated that storage within the Lower Roach Gulch Reservoir will be utilized first within the valley, with storage in Lower Sunshine Reservoir and Upper Sunshine Reservoir used second and third in priority, respectively. This proposed operation may vary slightly from year to year and month to month depending upon local precipitation conditions.

The GVID will attempt to maintain a 5,000 acre-feet minimum pool within Upper Sunshine Reservoir at all times, and would invade this pool only as "storage of last resort" within the valley. Provisions and agreements have been finalized between the GVID and the Wyoming Game and Fish Department (WGFD) which outline all specific operations, including: Greybull River bypasses at Lower Roach Gulch Diversion; minimum pool maintenance at Upper Sunshine Reservoir; and public access at Upper Sunshine Reservoir. Copies of the final agreement outlining these issues have been provided to the lead and cooperating agencies and it is anticipated that several of the items may be incorporated as "Permit Conditions" to the Section 404 Corps of Engineers Permit for the project, if issued.

2.3.3 ALTERNATIVE C: BLACKSTONE GULCH DAM AND RESERVOIR

This alternative is similar to Lower Roach Gulch and includes a diversion dam on the lower Greybull River, delivery canal, dam and reservoir, and delivery channel returning released storage water to the Greybull River for diversion downstream into the Farmers and Bench canals. Although the dam and reservoir would be located west of Alternative B in another drainage, the two alternatives are very similar in design and operation.

Blackstone dam would be located primarily in T. 50 N., R. 99 W., sec. 12, E½E½ (Figure 2.4). It would be a 115 foot-high, zoned-earth structure at the mouth of Blackstone Gulch. The crest length of the dam would be approximately 1,400 feet at an elevation of 5,190 feet. Two small saddle dikes of less than 15 feet in height would be built on the east side of the reservoir. An earth channel spillway would be included in the design and the existing channel leading from Blackstone Gulch would be used to discharge water from the outlets works back to the Greybull River. The channel would require armoring to prevent erosion from heavy flows. The reservoir would have a capacity of 30,000 acre-feet with a full pool surface acreage of about 700 acres.

The diversion dam design and construction would be identical to Alternative B's diversion structure. It would be located on private lands approximately 2 miles upstream from Alternative B's on the lower Greybull River.

The delivery canal would be approximately 2 miles long from the diversion dam to the reservoir. The first mile would be an open canal located on an upland bench adjacent to the Greybull River. The second mile would be through a 13-foot-diameter, concrete-lined tunnel. The tunnel would be constructed through sandstone, siltstone, and clay shales and terminate at the west abutment of the reservoir. The delivery canal and tunnel would be on private lands. The canal would pass through nonirrigated lands and thus there would be no turn-outs for irrigation water delivery along the canal. The canal crosses one small existing drainage. The crossing of this drainage would be designed to

allow runoff from the drainage to enter the canal (similar to the Alternative B canal crossing at Blackstone Gulch). An access road would follow the canal and tunnel.

The dam would be on privately-owned lands. These lands would have to be acquired. A portion of the spillway, the saddle dikes, and a majority of the reservoir would be on public lands. Fill for this alternative including material for dikes and for delivery canal construction would be obtained from upland, grassland bench borrow areas on public lands and possibly from an agricultural area south of the river. The type and amount of disturbance would be similar to Alternative B; however, the precise locations of borrow areas have not been identified.

The applicant has not conducted the same level of geologic and design investigations for this site as for its proposal. Therefore, more time may be required for implementation of the alternative in conducting final design, surveying, mapping, and final design drilling, laboratory testing, and analysis. Construction of the 1 mile of concrete lined delivery tunnel may also add to construction time. Overall, however, timing for implementation of the alternative would be similar to Alternative B. Workforce size required for construction of this alternative would be slightly higher than for the Lower Roach Gulch Alternative due to construction of the delivery tunnel.

Although public access would be allowed, minimal recreation facilities would be incorporated and the reservoir would not be stocked with fish. Preliminary wetland investigations conducted by WEST (1995b) indicated that approximately 12.92 acres of wetlands would be effected by implementation of this alternative. Detailed wetland delineations conducted in 1996 indicate that approximately 2.43 acres wetlands would be effected (WEST 1996c). The majority of these wetlands occur along the Greybull River between the diversion and the return channel for the Blackstone Gulch Reservoir.

Operation of the facility would be in conjunction with operation of the existing Upper Sunshine and Lower Sunshine reservoirs and would be nearly identical to Alternative B. A detailed description of the present operating plan and a likely plan for future operations with a lower valley reservoir is provided in Appendix A. As with Alternative B, an agreement with WGFD will be made insuring a minimum bypass in-stream flow of 50 cfs would be maintained at the Blackstone Gulch Diversion Dam. Also under this alternative, managers would attempt to maintain an active minimum pool of 5,000 acre-feet at Upper Sunshine Reservoir.

2.4 MITIGATION

The two action alternatives evaluated, Lower Roach Gulch and Blackstone Gulch reservoirs, are similar in size and location. Many of the environmental consequences of implementation of either alternative are similar (see Chapter 4.0 Environmental Consequences). Additionally, many of the impacts are considered temporary and insignificant. Of primary concern are impacts to the aquatic ecosystem (the Greybull River) and wetlands from potential dewatering during diversion of water to the reservoir.

Detailed descriptions of mitigation measures are provided in Chapter 5.0 Mitigation. Some of the measures proposed require conservation practices for protecting resources. For example, the proper use of water spreaders and erosion control measures at construction sites will decrease air quality impacts and potential sediment laden runoff from entering the Greybull River. A storm water management plan will be in place before construction begins to prevent storm water impacts and a maintenance of contaminants spill plan and response kit will be available on site. Operation of sluice gates at the diversion dam to discharge sediment buildup should be conducted during periods of high river flows when sediment loading is high. Construction within 0.5 mile of active raptor nests should not occur during the nesting season to prevent disturbance due to noise and activity.

Mitigation for impacts to plant communities center around successful reclamation (revegetation) of disturbed areas. A detailed reclamation plan that is site specific will be drafted and followed to successfully restore borrow and other construction areas to their former state. Impacts to plant communities as well as wildlife communities may be further reduced by minimizing impact to habitat adjacent to construction areas from vehicles and heavy machinery.

Altered Greybull River flows are expected to cause some adverse effects to the aquatic ecosystem. For example, altered late summer flows between the reservoir's discharge and the primary irrigation diversion canals could result in the loss of habitat for trout and whitefish in this stretch of river and construction of the diversion dam could block fish migration in the river. Mitigation for these impacts will center around maintaining river habitat for aquatic organisms by establishing minimum bypass flows to prevent dewatering of the river below the diversion dam, and providing a fish passage at the diversion dam during high flows. Chapter 5.0 further describes these mitigation measures.

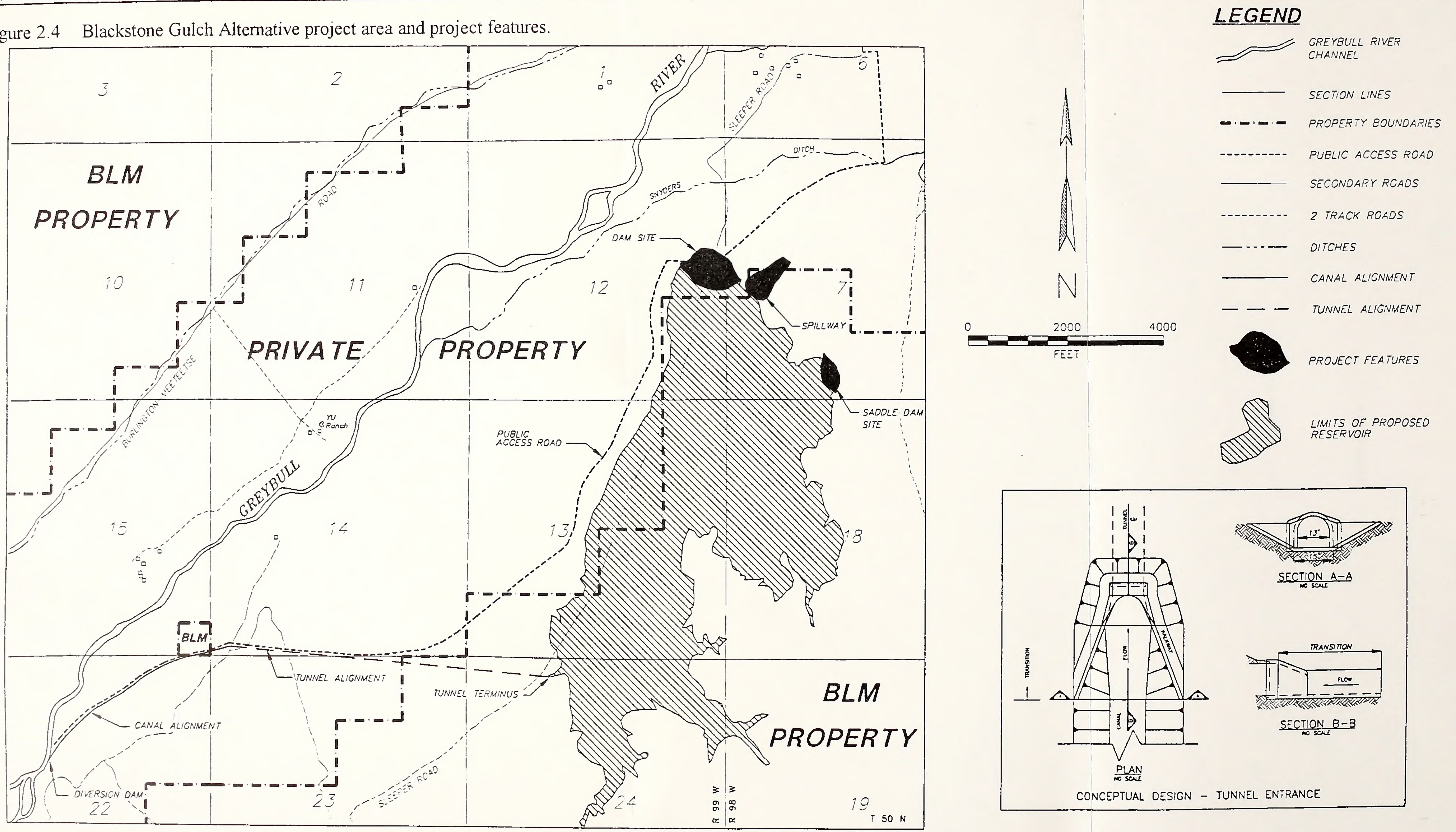
For each of the action alternatives, there is the potential for wetland impacts to occur in four locations: along the diversion canal, in the area that will be inundated (reservoir site), along the return flow route, and along the river between the diversion and return flow. Wetland impacts which cannot be avoided or minimized will be mitigated by replacement of the functions and values those wetlands provide. Wetland restoration, creation, and enhancement are used for mitigating wetland losses. In-kind, or establishing the same type of wetland being lost, and out-of-kind, establishing a different type of wetland are used and the location of the mitigation is referred to as on-site, in the immediate vicinity of the project within the same watershed, and off-site, removed from the project area often in a different watershed.

For either of the action alternatives, mitigating wetland losses along the diversion and return flow routes and at the reservoir site will center around creating in-kind wetlands on-site. Mitigation for losses along the river corridor will involve creation of maintenance free wetlands on-site. Wetland creation along the river will work in concert with mitigation for aquatic ecosystem impacts to enhance the whole Greybull River riparian corridor ecosystem. Wetland mitigation for each alternative is described in detail in Chapter 5.0.

Socioeconomic impacts are anticipated to housing, law enforcement, and health care. To mitigate housing impacts temporary housing on site can be provided by the contractor or lease arrangements can be used to provide housing at campgrounds or motels to construction workers. To meet increased law enforcement demands, an additional Big Horn County deputy or security personnel hired by the contractor can be employed. For health care impacts, the contractor should maintain an emergency medical response plan on site for construction related injuries and subsidize local fire and ambulance services to respond to accidents on site.

To mitigate impacts to cultural resources, evaluative testing will be conducted at sites eligible for nomination to the National Register of Historic Places. Depending on results of the testing further mitigation in the form of recovery (excavation) of buried cultural remains may be required.

Figure 2.4 Blackstone Gulch Alternative project area and project features.



LOCATION MAP DISPLAYING PROJECT FEATURES, BLACKSTONE GULCH ALTERNATIVE

CHAPTER 3.0 AFFECTED ENVIRONMENT

3.1 INTRODUCTION

This Chapter describes the physical, biological, social and economic components of the environment that may be affected by implementation of the proposed action or the alternatives. Descriptions of the physical and biological components apply generally to the Greybull River Valley and more specifically to those areas which would be directly and indirectly affected by project construction and operation. Economic, social, agricultural, and cultural elements deal with both the larger context of state, Bighorn Basin, and county as well as specifically with the project area. The project area for each alternative is defined as the area that would be inundated by each reservoir alternative, adjacent areas to be used for borrow material, the canal route from the Greybull River to the reservoir, the return flow route from the reservoir to the Greybull River, and in some cases, the river corridor between the diversion and return flow.

3.2 LAND FEATURES

3.2.1 GENERAL SETTING

The Greybull River Valley is located in north-central Wyoming in the Bighorn Basin. The axis of the Greybull River Valley lies generally from southwest to northeast from its headwaters in the Absaroka Range to its junction with the Bighorn River between the towns of Basin and Greybull.

3.2.2 GEOLOGY AND SOILS

The southern Absaroka Range is a volcanic plateau consisting of the Pitchfork Formation and the overlying Wiggins Formation which outcrops along the Wood River (Merrill 1974). Primary formations exposed along the Greybull River Valley in a downstream direction and of decreasing age are the Frontier Formation, Cody Shale, Mesaverde Formation, Meeteetse Formation, and the Lance Formation of Cretaceous age; and the Fort Union and Willwood formations of Tertiary age (Table 3.1, Figure 3.1).

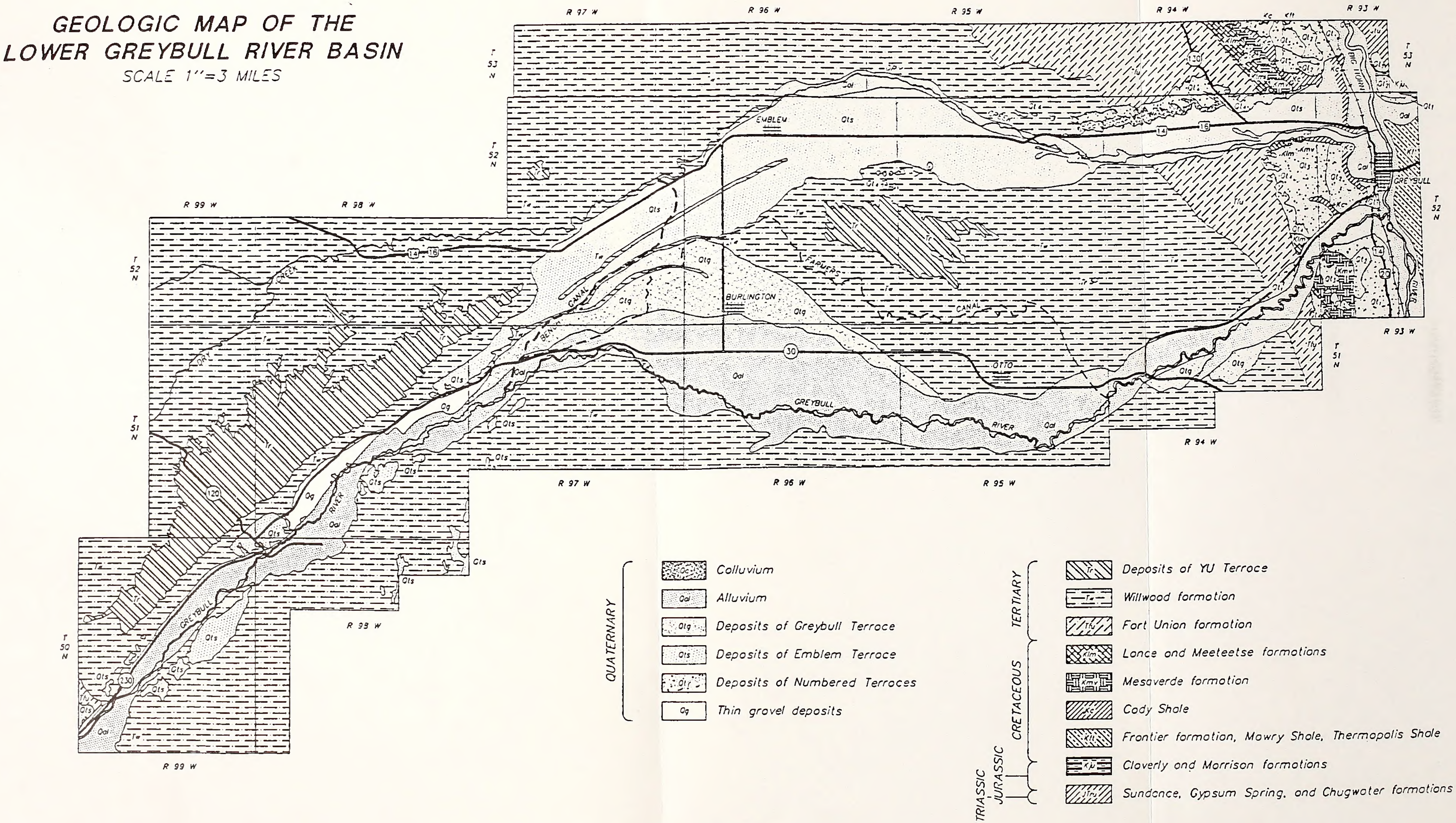
The lower portion of the Greybull River Valley where the majority of irrigation occurs is located primarily in alluvial deposits underlain and bounded by the Willwood Formation. Subsequent to the deposition of the Willwood Formation and the overlying Tatman Formation, volcanic rocks of the Absaroka plateau were formed. Remnants of the Tatman Formation are located along the southern boundary of the lower Greybull River Valley. Eastward flowing streams, including the ancestral Greybull River, eroded the volcanic rocks, carried the debris into the valley and deposited it over the Tatman and older formations. The Greybull River, during several stages of deposition and erosion, created a succession of terraces along the lower Greybull River Valley (Robinove and Langford 1963).

Table 3.1 Descriptions of geologic formations outcropping in the lower Greybull River drainage.

CENOZOIC AGE ROCKS	
Wiggins Formation	Basalt flows and flow breccia lying conformably on the Pitchfork Formation and grading laterally into volcanic sedimentary rocks in the Greybull Valley (late Eocene to Oligocene).
Pitchfork Formation	Oldest volcanic in southern Absaroka Mountains consisting of volcanic clastic lying unconformably on the Willwood and Tatman formations (mid-Eocene).
Tatman Formation	Drab nontuffaceous claystone, oilshale, lignite and sandstone of swampy to shallow lacustrine origin (Eocene).
Willwood Formation	Variegated, often red, claystone, shale and sandstone of continental origin lying conformably on the Fort Union Formation (Eocene).
Fort Union Formation	Brown to gray sandstone and conglomerate with gray to black shale and thin coal seams (Paleocene).
MESOZOIC AGE ROCKS	
Lance Formation	Thick bedded buff sandstone and drab to green shale with thin conglomerate lenses lying conformably on the Meeteetse Formation (Upper Cretaceous).
Meeteetse Formation	Well bedded and easily erodible gray clay and sandy clay with some brown clay, light gray sandstone and thin coal seams lying conformably on the Mesaverde Formation (Upper Cretaceous).
Mesaverde Formation	Light colored massive to thick-bedded sandstone with some sandy shale and coal (Upper Cretaceous).
Cody Shale	Erodible, dark gray to olive gray thinly bedded shale with some buff sandstone interbeds (Upper Cretaceous).
Frontier Formation	Thinly bedded buff sandstone with abundant shale and some bentonite interbeds, carbonaceous in lower part (Upper Cretaceous).

Most acreage irrigated from the Greybull River is located on terrace deposits along the Greybull River. The oldest major terrace along the river is the Tatman Mountain terrace. Only portions of this terrace are still visible on Tatman Mountain south of the Greybull River Valley and it is too high above the river to be irrigable. The second oldest major terrace is the YU terrace which includes the YU Bench, Table Mountain, and Bridger Butte, all located north of the Greybull River. No land on this terrace is irrigated. The Emblem terrace includes the Emblem Bench, upon which a large portion of the lands irrigated from the Greybull River through the Bench Canal are located, and the Agrarian Bench located just northwest of the town of Greybull.

Figure 3.1 Geologic formations of the Greybull River Valley.



When the Greybull River flowed at the elevation of the Emblem terrace, the mouth of the river was located approximately where Dry Creek enters the Bighorn River north of the Emblem Bench. Another tributary of the Bighorn River flowed in the location of the current lower Greybull River Valley. This tributary eroded headward and captured the Greybull River near the northeast end of the YU Bench, rerouting it south of the Emblem Bench and Table Mountain (Robinove and Langford 1963). The Greybull terrace is the most recent major terrace, located north of the current lower Greybull River floodplain, and includes some of the lands irrigated from the Farmers Canal.

The soils of the Greybull River Valley are classified in four broad taxonomic orders - Mollisols, Alfisols, Aridisols, and Entisols (Figure 3.2; Peterson et al. 1987). Soil surveys have not been completed for Park County or Big Horn County (J. Julian, NRCS, pers. commun.).

The majority of soils along the Greybull River in the lower Greybull River Valley consist of the Haplargids-Torrifluvents-Torriorthents Association (Figure 3.2). Soils along the irrigated benches and along the river are generally coarse-grained, deep deposits on ancestral or current floodplains of the river and are classified as Torrifluvents. Soils along alluvial fans from the tributaries of the Greybull River are medium- to fine-textured, deep deposits classified as Torriorthents. Haplargids are generally soils created from weathering of the geologic formations defining the margins of the valley and consist of a thin layer of topsoil with significant quantities of clay.

Soils in uplands on either side of the Greybull River Valley and along Table Mountain between the Emblem bench and the Greybull River consist of the Haplargids-Natragids-Torriorthents Association (Figure 3.2). Torriorthents are generally found along channels of tributaries to the Greybull River and form the alluvium of the tributaries. Haplargids are thin soils on the uplands. Natragids are similar to the Haplargids with significant quantities of clay, but also are high in sodium. Soils of this association are generally not suited for crop production.

The majority of irrigated land in the Greybull River Valley is located on the floodplain or terraces of the Greybull River on soils classified as Torriorthents or Torrifluvents. Approximately 20 percent of the irrigated land is classified as Class I for land capability which indicates that the land has slight or few limitations that restrict use for irrigated agriculture (Wyoming Water Planning Program 1974). Approximately 75 percent of the irrigated land is classified as Class II with moderate limitations that reduce choice of crops or require moderate conservation practices: 45 percent because of low water-holding capacity typical of alluvial soils; 15 percent because of slow permeability probably due to deposition of fine-grained sediments in alluvial fans; and 15 percent because the soils are wet, probably due to poor drainage particularly in the lower portions of the Greybull River floodplain. The remaining 5 percent of the irrigated land is classified as Class III with severe limitations to irrigation primarily due to steep slopes.

Lower Roach Gulch Alternative

The Lower Roach Gulch Reservoir is located on an unnamed gulch immediately west of Roach Gulch, a tributary of the Greybull River that enters the river from the south near the Big Horn and Park county line (Figure 1.1). The dam site is located at the point where the deeply incised gulch emerges from slopes of the Willwood Formation flanking the Greybull River Valley. The floor of the reservoir basin consists of up to 10 feet of silts and clays derived from the Willwood Formation. Sides of the floor of the basin are locally covered with alluvial and colluvial fan deposits at the base of the bedrock slopes. The sides of the basin are bedrock slopes of the Willwood Formation and consist of interlayered siltstones, sandstones, and claystones forming a "badlands" topography. Erosional sinks and cavities associated with the dispersive claystone bedrock are found in areas where softer claystone is exposed immediately beneath erosion-resistant sandstone layers. These sinks and cavities are surficial features. The tops of the interstream divides between tributaries entering the Greybull River from the south are covered with Tertiary terrace deposits consisting of silts, sands, fine to coarse gravels, and cobbles. The upper terrace deposits are rounded and derived from volcanic deposits in the Absaroka mountain range at the upper end of the Greybull River (GEI 1994a).

There are several faults in the Willwood Formation near the proposed reservoir site. These faults are 2 to 10 miles long and cross the region in a general N 60° E trend. Review of seismic data for the region and observation of geotechnical drilling data indicates that the faults are inactive (GEI 1994a).

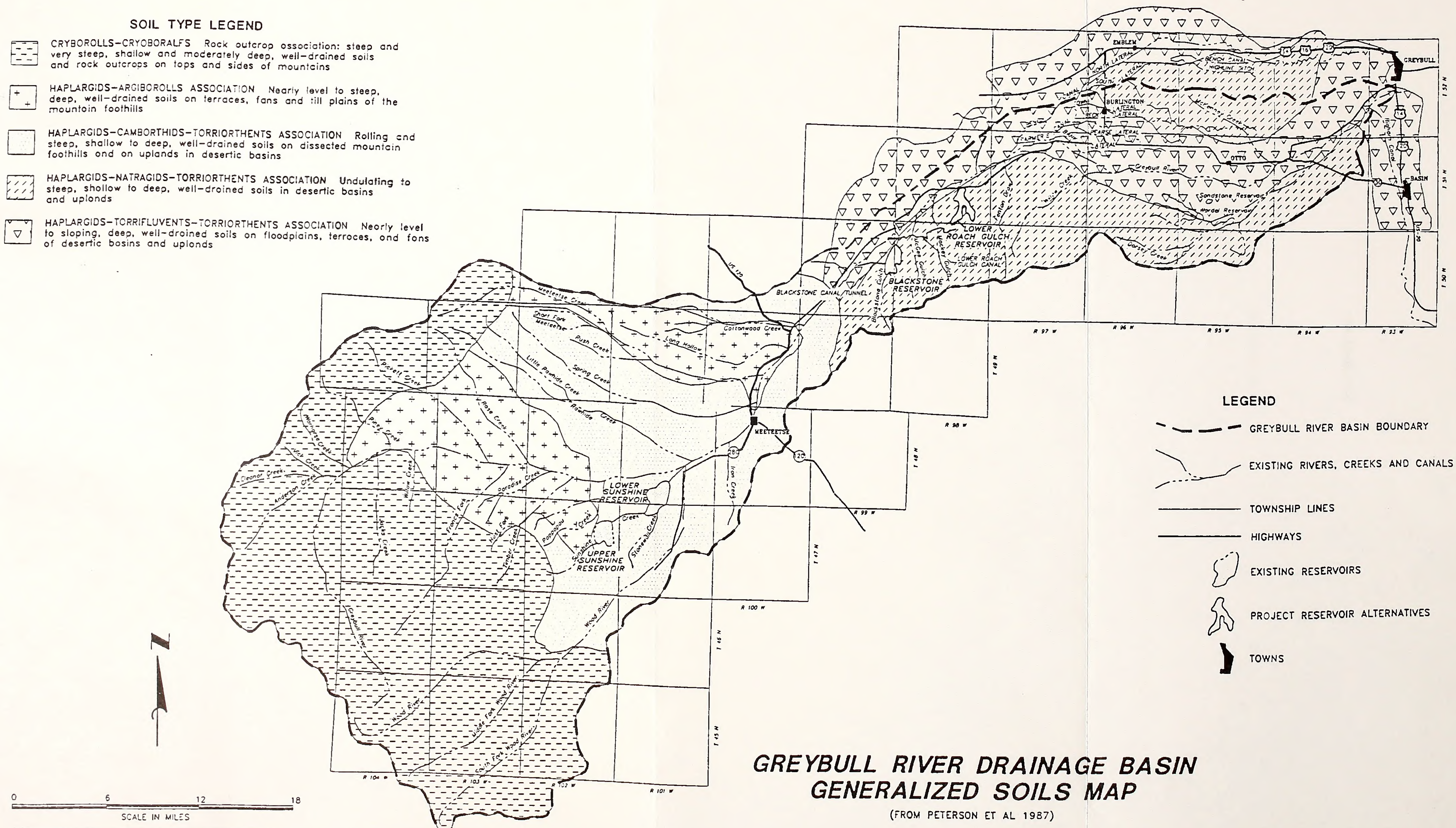
The water supply canal for the Lower Roach Gulch Alternative generally follows the base of the Willwood Formation outcrop from the diversion point to the reservoir. The first portion of the canal alignment crosses the lowest terrace deposits along the river and the final portion crosses a divide on the Willwood Formation to deliver water to the upper end of the reservoir. Several other tributaries are crossed along the alignment. Subsurface conditions along the canal alignment vary from up to 22 feet of silts, sands, and clays in the tributary crossings to thinly mantled bedrock along the lower end of the canal (GEI 1994a).

Soils on the reservoir bottom along the channel of Roach Gulch are primarily Torriorthents derived from erosion of the surrounding Willwood Formation. Soils on slopes surrounding the reservoir basin are primarily Haplargids. Haplargids derived from dispersive claystone bedrock and exposed claystone bedrock in the reservoir basin are highly erosive.

Blackstone Gulch Alternative

The Blackstone Gulch Reservoir Alternative is located on a tributary to the Greybull River that enters the river from the south approximately 8 miles upstream of Roach Gulch. Blackstone Gulch is very similar with regard to geology and soils. The first half of the water supply canal crosses the lowest terrace deposits along the river while the second half includes a tunnel through the Willwood Formation to deliver water to the reservoir.

Figure 3.2 Broad taxonomic soil groups of the Greybull River Valley.



3.2.3 MINERAL RESOURCES

All federal lands with mineral resources are currently open to leasable and locatable mineral exploration. Valuable mineral resources in the Greybull River Valley consist primarily of oil, natural gas, and coal. Oil and gas fields are located at the upper end of the valley, primarily near and above Meeteetse, and are associated with stratigraphic traps in Jurassic or older formations (Peterson et al. 1987). The abandoned Emblem Bench gas field was located on the YU Bench near the northeast end of the bench. Gas production was from the Frontier Formation (De Bruin and Boyd 1991).

Coal resources in the Greybull River Valley are generally associated with formations of Late Cretaceous and Tertiary age, primarily the Mesaverde and Fort Union formations. Coal in the area is generally subbituminous and is deeply buried in the lower end of the valley. Exploitable reserves south of the Greybull River Valley in the Grass Creek area are bituminous and located near outcrops of the Fort Union Formation (Peterson et al. 1987).

The Kirwin District in the headwaters of the Wood River, 40 miles southwest of the project, has experienced some mining and exploration for precious metals. Areas which have been explored are intrusive complexes penetrating volcanic deposits of the Wiggins Formation. Potential resources in the area include silver, gold, molybdenum, copper, and lead (Hausel 1989).

The terrace deposits and alluvium along the Greybull River contain deposits of sand and gravel that could be used for construction material and concrete aggregate. These resources are distributed throughout the valley and only a small portion have been developed.

Lower Roach Gulch Alternative

Mineral resources identified near the Lower Roach Gulch Alternative are limited to coal and sand and gravel deposits. This coal is in the Fort Union Formation which is stratigraphically below the surficial Willwood Formation. Since the Willwood Formation is up to 2,500 feet in thickness near the location of the Lower Roach Gulch dam site, coal beds in the Fort Union are not economically developable at this time. Sand and gravel deposits are located in the terrace deposits on the benches above Roach Gulch and in the Greybull River alluvium near the mouth of Roach Gulch. These deposits have not been developed to date.

Blackstone Gulch Alternative

Mineral resources identified in the Blackstone Gulch area are also limited to coal and sand and gravel deposits. Coal in the Blackstone Gulch area is not economically developable because of high overburden ratios. Sand and Gravel deposits in the Blackstone Gulch have not been developed.

3.3 WATER RESOURCES

3.3.1 SURFACE HYDROLOGY

The Greybull River flows in a northeasterly direction from its headwaters to its terminus on the Bighorn River between the towns of Basin and Greybull (Figure 1.1). A major tributary, the Wood River, enters the Greybull River from the south about 5 miles southwest of the town of Meeteetse at an elevation of approximately 6,000 feet. Dry Creek, which receives return flows from irrigation on the Emblem Bench, is a tributary of the Bighorn River located directly north of the Greybull River Valley. Dry Creek flows in an easterly direction from its headwaters on the plains southeast of Cody to its mouth on the Bighorn River just north of the town of Greybull.

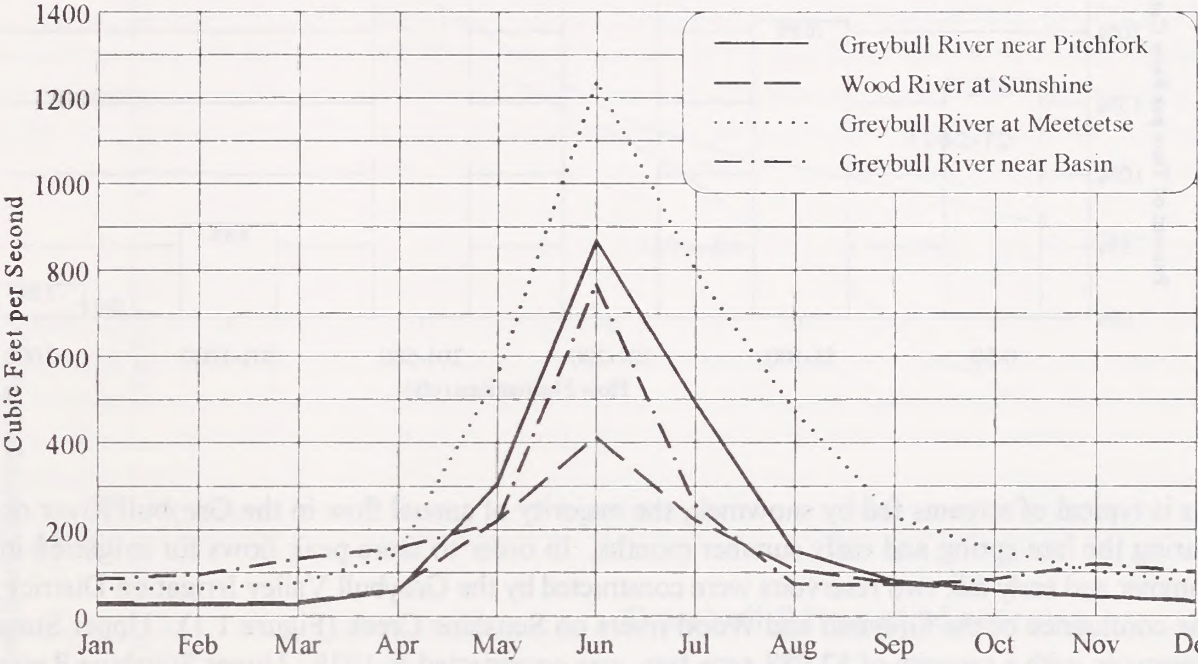
Average annual precipitation over the Greybull River drainage, which is 1,130 square miles, varies from under 7 inches per year at the lower end of the valley to over 60 inches per year at the upper end (Martner 1986). Average annual snowfall in the upper end of the drainage is over 150 inches per year. The accumulated snowpack melts slowly in the spring causing peak flows in the Greybull River to occur in June on average, although peak flows occurring as late as August have been recorded. Average annual runoff contributing to Greybull River flows is over 400 acre-feet per square mile in the mountainous headwaters and declines to approximately 15 acre-feet per square mile in desertic lower portions of the valley below Meeteetse (Peterson 1988). Annual precipitation over the Dry Creek Basin averages about 8 inches per year, substantially less than the Greybull River Valley, because the headwaters are not located in the high-precipitation mountainous areas (Martner 1986). Average annual runoff for the Dry Creek Basin is approximately 38 acre-feet per square mile, the majority of which is return flow from irrigation.

There are four USGS gaging stations with long-term recent periods of record in the Greybull River Valley. Proceeding downstream, they are: Greybull River near Pitchfork (06274500) with a continuous period of record from 1951 to 1971; Wood River at Sunshine (06275000), with a continuous period of record from 1946 to 1992; Greybull River at Meeteetse (06276500), with a continuous period of record from 1920 to present; and Greybull River near Basin (06277500), with a continuous period of record from 1930 to 1973. Figure 3.3 shows average monthly flows for each of these four gaging stations. A fifth station, Wood River near Meeteetse (06275500), has a 24-year period of record ending in 1949. Flows at the Greybull River near Basin station are significantly less than flows at the Greybull River at the Meeteetse station. The reduction in flows is due to large irrigation diversions located above the Basin station and below the Meeteetse station. Diversions for irrigation of nearly 14,000 acres on the Emblem Bench are also transported over the valley divide where return flows from irrigation flow to Dry Creek, the next drainage to the north.

Two gaging stations have been operated by the USGS in the Dry Creek Basin, both of which have limited periods of record. The Dry Creek at Greybull station (06278000) was operated from 1951 to 1954 and 1956 to 1959 while the Dry Creek near Greybull station (06277950) was operated from 1979 to 1981. The majority of flows in lower Dry Creek result from irrigation return flows from the Emblem Bench although water produced from the Oregon Basin Oil Field can provide a major

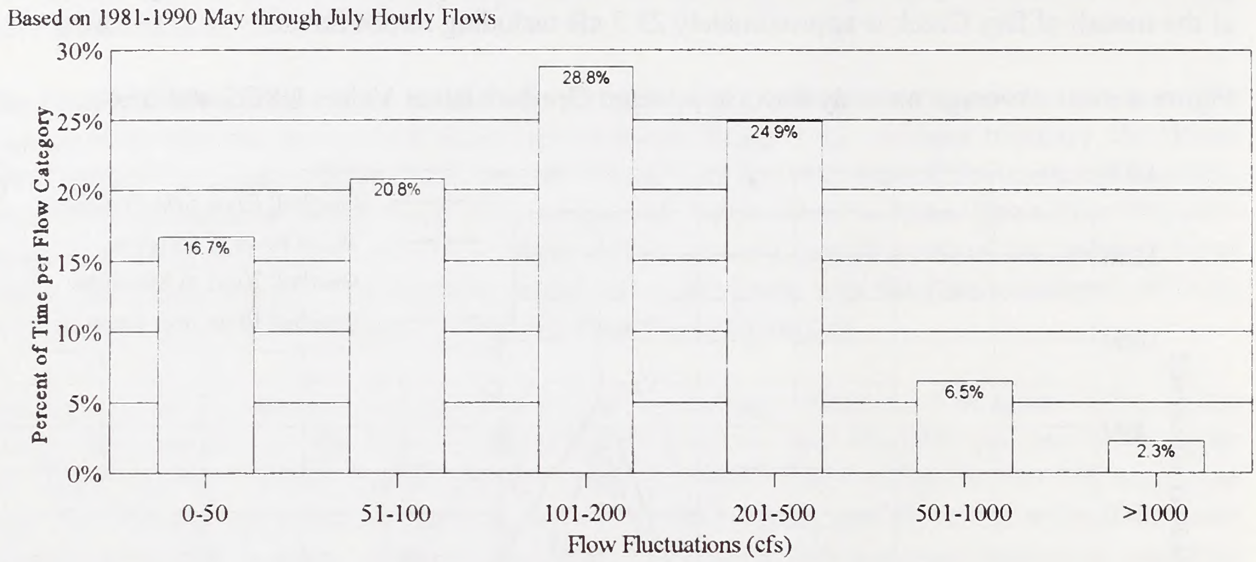
portion of the Dry Creek flows in the upper end of the drainage. Runoff from snowmelt in the valley generally occurs in early spring and continues for only a short period. Current average annual flow at the mouth of Dry Creek is approximately 23.3 cfs including return flows.

Figure 3.3 Average monthly flows at selected Greybull River Valley USGS stations.



Streamflow in the Greybull River can vary significantly within a 24-hour period due to variation in rate of snowmelt in the high elevation headwaters of the river (Figure 3.4). Only limited hourly streamflow data are available for the Greybull River stations. SWWRC obtained recorder charts from the USGS for the period 1981 through 1990 at the Greybull River at Meeteetse station and analyzed the charts to derive hourly streamflow data for the runoff period of May through July. Hourly streamflow data at the Greybull River at Meeteetse gauge were analyzed to determine the magnitude of fluctuations in streamflow during peak flow months. Although the Greybull River at Meeteetse gauge is located downstream of the storage reservoirs, releases from the reservoirs do not have a significant effect on fluctuations because, during periods of large fluctuations, the reservoirs are storing water, not releasing. Differences between maximum and minimum hourly flows for each 24-hour period from midnight of one day to midnight of the following day were calculated for each day of the period. Resulting differences were separated into ranges (Figure 3.4) and the occurrence percentage for each range was calculated. Fluctuations in excess of 1,000 cubic feet per second (cfs) in a 24-hour period occur during 2.3 percent of the days in the period of record. Fluctuations from 500 to 1,000 cfs occur during 6.5 percent of the days in the period of record and fluctuations from 200 to 500 cfs occur in 24.9 percent of the days. These fluctuations in flow frustrate operation of irrigation structures in the Greybull River Valley because continual adjustments must be made to diversion structures in order to divert uniform flows for ditch supplies.

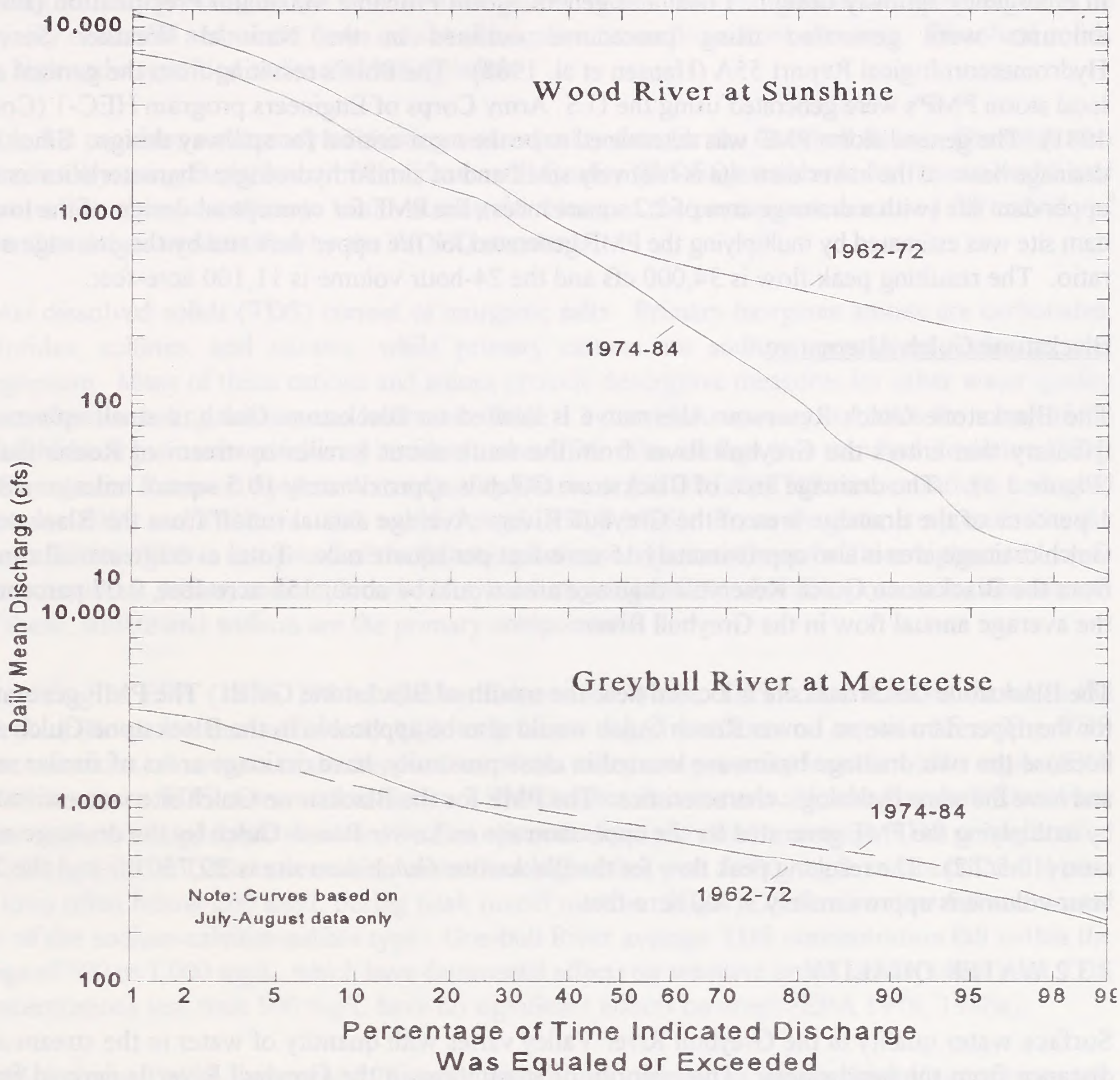
Figure 3.4 Daily streamflow fluctuations, Greybull River at Meeteetse station.



As is typical of streams fed by snowmelt, the majority of annual flow in the Greybull River occurs during the late spring and early summer months. In order to store peak flows for irrigation in late summer and early fall, two reservoirs were constructed by the Greybull Valley Irrigation District near the confluence of the Greybull and Wood rivers on Sunshine Creek (Figure 1.1). Upper Sunshine Reservoir, with a capacity of 52,988 acre-feet, was constructed in 1938. Upper Sunshine Reservoir is filled from the Greybull River through a diversion canal from the river to the upper end of the reservoir on Sunshine Creek. Lower Sunshine Reservoir was constructed in 1972 with a capacity of 58,900 acre-feet. Lower Sunshine is filled through a diversion canal from the Wood River and indirectly from the Greybull River through releases from Upper Sunshine Reservoir. Streamflow in the Wood River below the Lower Sunshine diversion was reduced significantly after operation of the diversion began because releases from Lower Sunshine Reservoir flow into Sunshine Creek and then the Greybull River and bypass the lower reaches of the Wood River. Figure 3.5 (Lowry et al. 1993) shows effects of operation of Lower Sunshine Reservoir on the Wood and Greybull rivers as analyzed by the USGS. High flows in the Greybull River near Meeteetse were reduced due to diversions to the reservoir and low flows were increased due to reservoir releases (Lowry et al. 1993).

As a result of irrigation in the Greybull River Valley, annual flows in Dry Creek have increased by an average 39,000 acre-feet and annual depletions to the Greybull River average approximately 137,000 acre-feet. Annual depletions to the Bighorn River and to Big Horn Lake average approximately 98,000 acre-feet as a result of water diversion and irrigation on the Greybull River in addition to depletions of approximately 1,100,000 acre-feet from all other water storage and delivery projects on the Bighorn and Wind rivers and their tributaries upstream of the convergence of the Greybull River (Wyoming Water Development Commission and University of Wyoming 1990).

Figure 3.5 Flow duration curves for selected Greybull River Valley USGS stations (Lowry et al. 1993).



Lower Roach Gulch Alternative

The Lower Roach Gulch Reservoir is located on a small ephemeral tributary that enters the Greybull River from the south near the Park and Big Horn county line (Figure 1.1). The drainage area of Roach Gulch is approximately 12 square miles or about 1 percent of the drainage area of the Greybull River. Average annual runoff for Roach Gulch is approximately 15 acre-feet per square mile (Lowry et al. 1993). Total average annual runoff from the Lower Roach Gulch Reservoir drainage area would be about 180 acre-feet, 0.07 percent of the average annual flow in the Greybull River.

An estimate of the critical storm Probable Maximum Flood (PMF) for a previously-considered dam site on the upper end of Lower Roach Gulch was prepared by GEI Consultants, Inc. (1994a) for use in emergency spillway design. Local and general storm Probable Maximum Precipitation (PMP) amounts were generated using procedures outlined in the National Weather Service Hydrometeorological Report 55A (Hansen et al. 1988). The PMF's resulting from the general and local storm PMP's were generated using the U.S. Army Corps of Engineers program HEC-1 (Corps 1981). The general storm PMF was determined to be the most critical for spillway design. Since the drainage basin of the lower dam site is relatively small and of similar hydrologic characteristics as the upper dam site (with a drainage area of 2.2 square miles), the PMF for conceptual design of the lower dam site was estimated by multiplying the PMF generated for the upper dam site by the drainage area ratio. The resulting peak flow is 34,000 cfs and the 24-hour volume is 11,100 acre-feet.

Blackstone Gulch Alternative

The Blackstone Gulch Reservoir Alternative is located on Blackstone Gulch, a small ephemeral tributary that enters the Greybull River from the south about 8 miles upstream of Roach Gulch (Figure 1.1). The drainage area of Blackstone Gulch is approximately 10.5 square miles or about 1 percent of the drainage area of the Greybull River. Average annual runoff from the Blackstone Gulch drainage area is also approximately 15 acre-feet per square mile. Total average annual runoff from the Blackstone Gulch Reservoir drainage area would be about 158 acre-feet, 0.07 percent of the average annual flow in the Greybull River.

The Blackstone Gulch dam site is located near the mouth of Blackstone Gulch. The PMF generated for the upper dam site on Lower Roach Gulch would also be applicable to the Blackstone Gulch site because the two drainage basins are located in close proximity, have drainage areas of similar size, and have the same hydrologic characteristics. The PMF for the Blackstone Gulch site was estimated by multiplying the PMF generated for the upper dam site on Lower Roach Gulch by the drainage area ratio (10.5/2.2). The resulting peak flow for the Blackstone Gulch dam site is 29,750 cfs and the 24-hour volume is approximately 9,700 acre-feet.

3.3.2 WATER QUALITY

Surface water quality in the Greybull River Valley varies with quantity of water in the stream and distance from the headwaters. The majority of streamflow in the Greybull River is derived from snowmelt in the mountainous headwaters and is low in contaminants. At the peak snowmelt times in spring and early summer, chemical constituents in the water are low throughout the length of the river. Suspended sediment concentrations usually peak in the spring and early summer because of erosion from overbank flows and snowmelt and rainfall runoff from the badlands surrounding the lower portion of the river.

Later in the summer and early in the fall, water originating in the headwaters of the stream decreases dramatically and the majority of it is diverted for irrigation. Most of the water in the river consists of irrigation return flows and inflows from lower valley tributaries. The amount of contaminants in

the water increases due to contact of groundwater return flows with the Willwood Formation and leaching of the soil profile in irrigated fields (Robinove and Langford 1963). Suspended sediment loading varies depending on the amount of irrigation return flows and rainfall on the badlands. The majority of late fall and winter flows consist of irrigation return flows from alluvium. Dissolved solids are high and suspended sediment loading is low.

Table 3.2 provides a summary of existing water quality data for the Greybull River. The table also provides Wyoming Department of Environmental Quality (WDEQ) standards for human health and aquatic life chronic and acute health standards. None of the parameters measured fall outside of tolerable ranges as identified by the WDEQ standards.

Total dissolved solids (TDS) consist of inorganic salts. Primary inorganic anions are carbonates, chlorides, sulfates, and nitrates, while primary cations are sodium, potassium, calcium, and magnesium. Many of these cations and anions provide descriptive measures for other water quality parameters including salinity and hardness. Table 3.2 provides summary statistics for many of the individual inorganic salts which may be measured as TDS. The average (± 1 standard deviation [SD]) of Storage and Retrieval System Water Quality Database (STORET) TDS concentrations collected between 1950 and 1992 was 661 ± 185.5 mg/L (EPA 1995). From the data, it appears that the Greybull River TDS is comprised of the following cations and anions (in order from highest to lowest concentrations): sulfate, sodium, bicarbonate, calcium, magnesium, chloride, potassium, and nitrate. Of these, sulfate and sodium are the primary components.

According to EPA (1976, 1986a) Quality Criteria for Water, TDS concentrations found in the Greybull River are not sufficiently high to produce negative effects on aquatic life. The TDS concentrations of streams in the headwaters of the valley are generally less than 100 mg/L (EPA 1995); however, TDS concentration increases with distance downstream. At the Greybull River near Basin station, located approximately 12 miles upstream from the mouth, average TDS concentration is 660 mg/L. The TDS concentration varies from highs often over 1,000 mg/L in late fall and winter to lows often below 200 mg/L during peak runoff months. High TDS flows in late fall and winter are of the sodium-calcium-sulfate type. Greybull River average TDS concentration fall within the range of 500 to 1,000 mg/L, which have detrimental effects on sensitive crops, while water with TDS concentrations less than 500 mg/L have no significant effects on crops (EPA 1976, 1986a).

Total hardness ($CaCO_3$) averaged 297 mg/L, with bicarbonate as the principal hardness component. Based on average hardness, Greybull River water would be classified as very hard; therefore, potential toxicity of hardness-based metals is significantly reduced.

Sodium comprises about 44 percent of cations in Greybull River water on average. The sodium-adsorption ratio (SAR) for surface water in the Greybull River Valley is low, averaging 2.78 at the Greybull River near Basin station. The sodium hazard of water used for irrigation is therefore low. The salinity hazard is high during portions of the year due to the large TDS concentrations.

Table 3.2 Summary of water quality data measured in the Greybull River at the Basin, Wyoming USGS gaging station. The period of record extends from August 1950 to September 1992 (EPA 1995).

								WDEQ Standards		
Parameter	Type	Units	No.[1]	Mean[2]	Max	Min	S.D.	Human[3]	Aquatic Life[4,5]	
2,4,5-T	Whole sample	µg/L	52	0.01	0.05	0.00	0.01			
2,4-D	Whole sample	µg/L	52	0.19	4.30	0.00	0.61	100		
2,4-Dichloropropene		Tot µg/L	45	0.01	0.05	0.00	0.01			
Air temperature		°C	75	18.23	34.00	-5.00	9.82			
Aldrin	Total	µg/L	7	ND				0.00013		1.5
Banvel	Total	µg/L	40	0.08	0.70	0.01	0.13			
Boron	Dissolved	µg/L	111	81.35	190.00	0.00	36.53			
Bromide		mg/L	3	0.40	0.51	0.29	0.09			
Calcium hardness	Calcium	mg/L	260	292.19	481.00	0.00	77.87			
Calcium	Dissolved	mg/L	260	71.25	120.00	25.00	17.57			
Chloride	Total	mg/L	260	9.22	28.00	0.00	5.07		230	860
Chlordane	TECH&MET	Tot µg/L	7	ND				0.00058	0.0043	1.2
Clopyralid	Total recoverable	µg/L	2	0.02	0.03	0.01	0.01			
Conductivity	25°C	µmho	148	961.91	1730.00	228.00	268.34			
CO2	Gas	mg/L	44	3.71	10.00	0.80	2.52			
CO3 ion (carbonate)	CO3	mg/L	205	1.46	16.00	0.00	3.18			
Color		Units	6	3.67	10.00	1.00	2.98			
DDD	Whole sample	µg/L	7	ND				0.00083		
DDE	Whole sample	µg/L	7	ND				0.00059		
DDT	Whole sample	µg/L	7	ND				0.00059	0.001	0.55
Diazinon	Whole sample	µg/L	7	ND						
Dieldrin	Total	Tot µg/L	7	ND				0.00014	0.0019	1.25
Dissolved solids	Sum	mg/L	168	660.93	1090.00	142.00	185.49			
Dissolved solids		tons/AF	204	0.91	1.67	0.19	0.26			
Dissolved solids		tons/day	202	258.78	7520.00	0.58	616.72			
Endosulfan	Whole sample	µg/L	5	ND				0.93	0.056	0.11
Endrin	Total	µg/L	7	ND				0.2	0.0023	0.09
Ethion	Whole sample	µg/L	7	ND						
Fluoride	Dissolved	mg/L	245	0.48	1.50	0.00	0.20			
Gamma-BHC	Lindane	Tot µg/L	7	ND				0.019	0.08	1.0
HCO3 ion (bicarbonate)	HCO3	mg/L	217	282.45	530.00	98.00	67.92			
Heptachlor		Tot µg/L	7	ND				0.00021	0.0038	0.26
Heptachlor epoxide		Tot µg/L	7	ND				0.0001	0.0038	0.26
Iron		µg/L	25	100.00	390.00	10.00	90.20	300	1000	
Iron	Dissolved	µg/L	25	140.00	590.00	0.00	138.97	300	1000	
Iron	Total	µg/L	53	92.26	440.00	0.00	85.62	300	1000	
Malathion	Whole sample	µg/L	7	ND					0.1	
Manganese		µg/L	1	100.00	100.00	100.00	0.00	50		
Magnesium	Dissolved	mg/L	260	28.03	52.00	3.20	8.74			
Mirex	Whole sample	µg/L	3	ND					0.001	
Methyl parathion	Whole sample	µg/L	7	ND						
Methoxychlor	Whole sample	µg/L	1	ND				100	0.03	
Methyl trition	Whole sample	µg/L	7	ND						
Sodium and potassium		mg/L	8	88.88	114.00	60.00	16.50			
Suspended sediment discharge		tons/day	5	26093.18	130000.00	4.90	51953.54			

Parameter	Type	Units	No.[1]	Mean[2]	Max	Min	S.D.	WDEQ Standards		
								Human[3]	Aquatic Life[4,5]	
Napthalenes	Poly chloronated	µg/L	5	ND						
Napthalenes	Total recoverable	µg/L	1	ND						
Non-carbonate hardness		mg/L	217	63.25	390.00	0.00	40.67			
Ammonia (NH3+NH4-N)	Total	mg/L	4	0.07	0.08	0.03	0.02		(1)	(2)
Nitrate	Dissolved	mg/L	173	1.62	14.00	0.00	1.47	10000		
Nitrate	Total	mg/L	8	2.03	4.00	0.50	1.00	10000		
Nitrite	Dissolved	mg/L								
Nitrate-nitrite nitrogen NO3 & NO23	Dissolved	mg/L	71	0.64	2.20	0.08	0.40			
Nitrate-nitrite nitrogen NO3 & NO2	Total	mg/L	4	1.05	1.70	0.30	0.54			
Nitrate nitrogen NO3-N	Dissolved	mg/L	81	0.47	3.20	0.00	0.41			
Parathion	Whole sample	µg/L	7	ND					0.013	0.065
PCBs	Whole sample	µg/L	7	ND				0.000044	0.014	
Percent sodium		%	199	43.46	63.00	31.00	7.17			
Perthane	Whole sample	µg/L	2	ND						
pH	Field	SU	156	8.06	8.70	7.10	0.31		6.5-9	
pH	Lab	SU	60	8.23	9.00	7.50	0.27		6.5-9	
Phenols	Total	µg/L	15	6553.33	10000.00	1000.00	2823.91	21000		
Total phosphorus		mg/L P	144	0.18	8.70	0.00	0.78			
Picloram	Whole sample	µg/L	39	0.02	0.20	0.01	0.03			
Potassium	Dissolved	mg/L	234	3.53	16.00	0.10	1.47			
Residue	Dissolved 180 °C	mg/L	105	654.48	1230.00	198.00	193.31			
Selenium	Dissolved	µg/L	8	2.81	5.00	2.50	0.83	10	5	20
Silica	Dissolved	mg/L	245	15.42	27.00	0.00	3.17			
Silvex	Whole sample	µg/L	52	0.00	0.03	0.00	0.00	10		
Sodium	Adsorbtion ratio		194	2.78	6.50	0.80	1.00			
Sodium	Dissolved	mg/L	234	112.85	283.00	17.00	45.63			
Stream flow		cfs	126	256.83	5830.00	8.00	654.02			
Sulfate	Total	mg/L	265	280.88	628.00	0.30	102.50			
Suspended sediment		mg/L	17	801.99	13900.00	20.00	3700.23			
Total alkalinity	CACO3	mg/L	201	236.28	700.00	80.00	64.37			
Total hardness	CACO3	mg/L	225	297.09	680.00	78.00	79.15			
Total Kjeldahl nitrogen		mg/L	4	1.73	4.40	0.40	1.57			
Toxaphene	Total	µg/L	7	ND				0.00073	0.0002	0.73
Trithion	Whole sample	µg/L	7	ND						
Water temperature		°C	247	11.36	28.00	0.00	8.67			
Water temperature		°F	247	52.45	82.40	32.00	15.60			

ND=Not Detected

[1]Number of measures

[2]If concentrations were reported as less than detection limits, then one-half the detection limit concentration was used to calculate the average and standard deviation.

[3] Human health standard

[4,5] Aquatic life chronic and acute standards respectively

(1) Ranges from 0.0091 to 0.37 depending on pH, temperature, and aquatic species present

(2) Ranges from 0.0007 to 0.050 depending on pH, temperature, and aquatic species present

The lower Greybull River is aggrading, which refers to the geologic process by which streambeds, floodplains, and bottoms of other water bodies are raised in elevation by the deposition of material

eroded and transported from other areas (AFS 1985). Historical data indicate that the Greybull River experiences highly variable shifts in suspended sediment concentrations and sediment transport. Physical evidence of the aggrading condition is provided within the morphology of the lower Greybull River. The channel is highly braided, a condition usually associated with steep slopes; however, the lower Greybull River has a very low slope. This would suggest that the river is receiving more sediment than it is capable of transporting. Observations of other rivers led Lane (1957) to conclude that the two primary causes of braided conditions are (1) overloading (for example, the stream is supplied with more sediment than it can carry), and (2) steep slopes.

The primary mechanisms affecting sediment concentrations and transport are spring runoff, irrigation return waters, and vegetation condition and cover values. The sparse vegetative cover in the "badlands" in the lower Greybull River Valley allow for erosion causing increased sediment concentrations in runoff from these areas. Suspended sediment (TSS) concentrations in the headwaters are generally low, often less than 10 mg/L. However, large runoff events can cause significant TSS concentrations in the headwaters. A snowmelt event on headwaters of the Wood River resulted in a measured TSS of 2,210 mg/L (EPA 1995). The average (± 1 SD) suspended sediment concentration calculated from STORET data measured at the USGS gaging station near Basin equaled 802 mg/L (± 3,700 mg/L). Concentrations of TSS encompassing this mean ranged from 20 to 13,900 mg/L (EPA 1995). Higher values usually result from valleywide runoff events that cause overbank flows throughout the length of the river as well as inflows from ephemeral streams draining the badlands.

Turbidity (measured in terms of light scattering at 90° angles) in the Greybull River is generally correlated with TSS. Turbidity data were not available in the STORET database; however, turbidity was measured during recent sturgeon chub studies conducted by the WEST Team (WEST 1996a). Turbidity for the lower 12 miles of river prior to irrigation season averaged 27 (range 10.6 to 90) Nepholometirc turbidity units (NTU). During the sturgeon chub study, turbidity in the Greybull downstream of the Bighorn Canal was measured at 490 NTUs. These data as well as TSS data suggest that particles in suspension in Greybull River water are highly variable. Turbidity and TSS concentrations do not appear to have a 1:1 relationship; however, as mentioned above, for those areas where suspended sediments are expected to be reduced, then turbidities should also be reduced. The data further suggest that mechanisms that cause turbidity are not consistently present.

Other chemical constituents in the Greybull River generally fall within WDEQ/WQD (1990) water quality criteria for streams. Conventional pollutants, metals, organics, and nutrients monitored at the USGS gaging station near Basin are summarized in Table 3.2. The STORET data indicate that, except for one measurement, which was equal to the chronic aquatic life standard (5 ug/L), all selenium concentrations measured between 1989 and 1991 were less than the standard (Table 3-2). This measurement occurred during a low-flow period and is probably due to long periods of contact of irrigation return flows with the Willwood Formation, which can contain selenium.

Iron concentrations exceeded standards in the STORET data only during low flow periods when streamflow is comprised primarily of return flow from irrigated lands. The high concentrations of

iron probably came from contact of return flows with the Willwood Formation which contains oxidized iron as evidenced by the often red color of its claystone, shale, and sandstone. The pH measurements, as reported in the STORET data, approached the upper limit of the WDEQ standard also only during low flow periods and only reached the upper limit once in 216 measurements.

The STORET data for water quality indicated that no heavy metal or pesticide concentrations measured in the water column have exceeded ambient water quality criteria for protection of aquatic life. Only one organic chemical, phenol, was measured at concentrations greater than the chronic criterion (2,560 ug/L). Phenols were detected at concentrations up to 10,000 ug/L, less than half of the human health limit of 21,000 ug/L (WDEQ/WQD 1990). The most likely source of phenols is from the use of phenoxy herbicides (Salisbury and Ross 1978). Phenols can be found as manufacturing impurities in these herbicides and can result from the breakdown of herbicides in sunlight (Guenzi et al. 1974). The high concentrations of phenols were from measurements taken between 1965 and 1966, prior to the existence of any phenol criterion and the high concentrations were probably due to the more liberal use of the herbicide at that time and the lower manufacturing standards that were prevalent before the development of water quality standards.

The STORET data are available for concentrations of organic chemicals in Greybull River sediment from 1976 to 1992 (Table 3.3). Sediment concentrations of 21 organic chemicals (primarily pesticides) were available. Seven of the 21 chemicals were detected at concentrations greater than the analytical detection limits, including chlordane, dieldrin, lindane, DDT, DDE, heptachlor epoxide, and PCBs. These are hydrophobic, highly persistent chemicals (that is, they do not mix with water, typically bind to sediments, and degradation takes a long time). Because these compounds are bound to the sediments, their bioavailability is very low; therefore, potential toxicity of these compounds to fish is very low. Potential toxic effects of these compounds to other aquatic life such as benthic macroinvertebrates is not apparent; however, the average concentration of dieldrin would exceed the draft sediment quality criteria (0.011 μg/Kg) currently being proposed by EPA. There are no WDEQ standards set for chemical constituents in sediment.

Chlordane, dieldrin, lindane, DDT, and heptachlor are chlorinated hydrocarbons that were used as broad-spectrum insecticides and, in the case of chlordane, fungicides for agricultural purposes. DDE and heptachlor epoxide are metabolites of DDT and heptachlor, respectively, that result from microbial metabolism. (Guenzi et al. 1974, AWWA 1990). Use of these chemicals for insect control in agriculture was banned in the 1970s (AWWA 1990). Lindane is still used in shampoos for lice control in humans and animals and heptachlor is still used for subterranean termite control and dipping roots and tops of nonfood plants (AWWA 1990). Use of these chemicals was banned because they are highly persistent carcinogens and concentrations detected are probably residual from agricultural use prior to their cancellation.

Polychlorinated biphenyls (PCBs) were widely used in heat-transfer fluids, hydraulic fluids, and transformers (AWWA 1990). Use of PCBs was canceled in 1976 because they are also highly persistent carcinogens. The amounts detected are probably residual from spills occurring before PCBs were canceled.

Table 3.3 Summary of sediment quality data measured in the Greybull River at the Basin, Wyoming USGS gaging station. The period of record extends from August 1976 to September 1992.

Parameter	Type	Units	Number of Measures	Average[1]	Max	Min	Standard deviation
2,4,5-T	Mud	µg/Kg	6	ND			
2,4-D	Mud	µg/Kg	6	ND			
2,4-Dimethyl phenyl	Dry wgt	µg/Kg	2	ND			
Aldrin	Dry wgt	µg/Kg	8	ND			
Chlordane	Mud	µg/Kg	8	1.00	3.00	0.00	1.32
DDD	Mud	µg/Kg	8	ND			
DDE	Mud	µg/Kg	8	0.04	0.20	0.00	0.07
DDT	Mud	µg/Kg	8	0.01	0.10	0.00	0.03
Dieldrin	Dry wgt	µg/Kg	8	0.20	0.80	0.00	0.26
Endosulfan	Mud	µg/Kg	2	ND			
Endrin	Dry wgt	µg/Kg	8	ND			
Lindane	Dry wgt	µg/Kg	8	0.01	0.10	0.00	0.03
Heptachlor	Dry wgt	µg/Kg	8	ND			
Heptachlor epoxide	Dry wgt	µg/Kg	8	0.11	0.70	0.00	0.23
Mirex	Bot Mat	µg/Kg	2	ND			
Methoxychlor	Mud dry	µg/Kg	2	ND			
PCBs	Mud	µg/Kg	8	0.63	4.00	0.00	1.32
PCNs	Mud	µg/Kg	2	ND			
Perthane	Dry wgt	µg/Kg	2	ND			
Silvex	Mud	µg/Kg	6	ND			
Toxaphene	Dry wgt	µg/Kg	8	ND			

ND = Not Detected

[1] If concentrations were reported as less than detection limits, then one-half the detection limit concentration was used to calculate the average and standard deviation.

Water in major reservoirs in the Greybull River Valley is generally of high quality. Both major reservoirs, Upper Sunshine and Lower Sunshine, are located high in the valley and store water that is low in chemical constituents and TSS (Robinove and Langford 1963). Some sediment loading and increases in turbidity can occur due to wave action in the reservoirs, but is probably not significant.

Water quality data for the Dry Creek drainage is limited. Some sampling was done from 1956 through 1958 in preparation for a USGS study of Greybull River and Dry Creek drainages (Robinove and Langford 1963). Sampling since then primarily consists of infrequent spot samples. In general, TDS concentrations of water in Dry Creek above Emblem are high, ranging from 3,000 to 10,000 mg/L. Return flows from the Emblem Bench are of relatively high quality and flows in Dry Creek below Emblem generally have TDS concentrations from 1,000 to 1,500 mg/L when return flows make up most of the total streamflow. The TDS concentrations in lower Dry Creek increase from 2,000 to 3,000 mg/L and the salinity hazard is very high when flow drops to less than approximately 10 cfs. Boron concentrations were found to be a potential problem in Dry Creek above Emblem. Dilution provided by return flows from the Emblem Bench was sufficient to reduce boron concentrations to levels acceptable for irrigation in flows below Emblem. There is insufficient data

on TSS concentrations and turbidity in the Dry Creek Drainage to characterize these variables. Review of the spot sampling data (EPA 1995) indicates that TSS concentrations and turbidity are high when runoff from the Dry Creek drainage comprises the majority of the streamflow and low when most of the streamflow is comprised of return flows.

The majority of available groundwater in the Greybull River Valley is found in terrace deposits along the Greybull River and the alluvium of the Greybull River. The TDS concentrations of groundwater in the terrace and alluvial deposits range from 250 to 2,000 mg/L. In general, groundwater in the upper part of the valley has TDS concentrations from 500 to 1,000 mg/L and is of the calcium bicarbonate type. Average TDS concentrations are less than 700 mg/L. Groundwater in the lower part of the valley (below Otto) has TDS concentrations from 1,600 to 2,000 mg/L and is of the sodium calcium sulfate type. Average TDS concentrations for groundwater in the lower valley are more than 1,500 mg/L (Robinove and Langford 1963).

Since most of the groundwater in the terrace deposits and alluvium is supplied by recharge from irrigation, quality of groundwater is related to quality of the irrigation water used. In the lower portion of the valley, a large portion of water diverted consists of return flows from irrigated land in the upper portion of the valley. Some of the increase in TDS is due to reuse of return flows. The remainder of the increase in TDS is due to inefficient drainage of irrigated lands above the current Greybull River alluvium. In the upper portion of the valley, a significant percentage of lands irrigated are on the Emblem terrace and the Greybull terrace. These lands are well-drained because of the topographic location of the terraces. In the lower portion of the valley, most irrigated lands are in the current Greybull River alluvium. The land is lower in elevation with respect to the river and the gradient of the river is also less. Groundwater moves through the alluvium slowly and is in contact with the underlying Willwood Formation for a long period. The change from a calcium bicarbonate type water to a sodium calcium sulfate type of water is probably due to contact with the Willwood Formation which is high in sodium and sulfates (Robinove and Langford 1963).

Lower Roach Gulch Alternative

The Lower Roach Gulch Reservoir is located in a valley in the Willwood Formation. Due to the amount of fine-grained material in the gulch alluvium, permeability of the alluvium is very low. Groundwater was not found in the alluvium during geotechnical drilling because the ephemeral nature of the gulch, when combined with the composition of the alluvium, makes it unlikely that significant groundwater recharge would occur.

Blackstone Gulch Alternative

The Blackstone Gulch Reservoir Alternative is very similar to the Lower Roach Gulch Alternative with regard to structure of the reservoir basin and composition of the alluvium. It is unlikely that significant groundwater is located in the Blackstone Gulch alluvium.

3.3.3 GROUNDWATER HYDROLOGY

Groundwater supplies in the Greybull River Valley are limited. Some potential exists for development of groundwater in the Fort Union and Willwood formations, but the majority of groundwater supplies are located in the Emblem and Greybull terraces and Greybull River alluvium (Robinove and Langford 1963). Potential also exists for development of Paleozoic aquifers, primarily the Madison and Bighorn formations, but the great depth of these formations (15,000 to 18,000 feet) beneath the irrigated portion of the Greybull River Valley makes development economically infeasible at this time (GEI 1994b).

The Fort Union Formation outcrops in the Greybull River Valley at the eastern end of the valley along the Bighorn River and at the western end of the valley near Meeteetse. In the center of the irrigated areas of the valley, the Fort Union Formation is deeply buried beneath the Willwood Formation. The Fort Union contains primarily sandstone and shale. Yields of wells completed in the formation would be limited and would probably only be adequate for domestic and livestock use (Robinove and Langford 1963, Plafcan et al. 1993). The Willwood Formation directly underlies most of the surface of the lower Greybull River Valley where it is not covered by recent alluvial deposits or terraces of the Greybull River. Yields from wells completed in the Willwood Formation are small, typically from 3 to 6 gallons per minute (Robinove and Langford 1963, Plafcan et al. 1993).

The deposits of the Emblem terrace consist of the Emblem Bench, the Agrarian Bench, and small terrace remnants along the Greybull River Valley upstream of the Emblem Bench (see Figure 3.1). The terrace deposits consist of poorly sorted gravel, sand, and silt derived from erosion of volcanic rocks in the Absaroka Range to the west. Groundwater in the Emblem terrace is primarily supplied by recharge from irrigation and the water table annually fluctuates as much as 10 feet depending on irrigation patterns (Robinove and Langford 1963). Yields of wells completed in the Emblem terrace are high, often more than 1,000 gallons per minute, but the terrace deposits are relatively thin -- from 10 feet in thickness on the northern edges of the terrace to a maximum of about 60 feet on the southern edge southeast of the town of Emblem. Due to thinness of the deposits, yields from wells would probably decrease significantly with extended pumping.

The Greybull terrace deposits are located south of the Emblem Bench and north of the Greybull River alluvium (see Figure 3.1). Deposits of this terrace also consist of poorly sorted gravel, sand, and silt. Thickness of the deposits ranges from about 15 feet to a maximum of 47 feet with the average closer to 15 feet. Groundwater in the Greybull terrace is also primarily supplied by recharge from irrigation. Yields from wells completed in the Greybull Terrace can be moderate to large in areas where the saturated thickness is greatest (Robinove and Langford 1963).

The Greybull River alluvium is located along the Greybull River and is composed of the same materials as the terrace deposits. Average thickness of the alluvium is approximately 30 feet. The source of groundwater in the alluvium is also primarily recharge from irrigation. Yields from wells completed in the alluvium can also be moderate to large depending on the saturated thickness of deposits in the area of the wells (Robinove and Langford 1963).

Lower Roach Gulch Alternative

The Lower Roach Gulch Reservoir is located in a valley in the Willwood Formation. Results of preliminary geotechnical drilling indicate alluvial deposits along the gulch consist of interbedded silty to clayey sands, sandy clays, and sandy gravel overlying bedrock of the Willwood Formation (GEI 1994a). Permeabilities of the alluvium and bedrock were low (from 0 to 880 ft/yr) and no groundwater was encountered.

Blackstone Gulch Alternative

The Blackstone Gulch Reservoir Alternative is located in a valley in the Willwood Formation similar to Roach Gulch. No drilling has been done at this site, but it should be similar to the Lower Roach Gulch site with regard to groundwater occurrence and permeability of the alluvium.

3.3.4 WATER RIGHTS

Water rights in Wyoming are issued by the Wyoming State Engineer's Office through a permitting process. Priority of water rights is decided by date of application, "first in time, first in right". The process begins by submitting an application for a direct flow surface water right, an enlargement of a direct flow surface right, a reservoir, a stock reservoir, a spring, a well, or an enlargement of a well to the State Engineer's Office. The State Engineer's Office reviews the application and, if it is in proper order, issues a permit for the water right. The applicant is responsible for commencing construction, ending construction, and applying the water to beneficial use within given time periods set by the State Engineer's Office. Notices are filed with the State Engineer's Office at the completion of each of these stages. After filing of the notice of beneficial use, use of the water is inspected by the Wyoming State Board of Control and a proof of appropriation or proof of construction is submitted to the Water Division Superintendent of the Board of Control. Upon submittal of the proof, the Board of Control issues a certificate of appropriation or certificate of construction. At this point the water right is an adjudicated right. Prior to issuance of the certificate of appropriation, the right is considered an unadjudicated right.

Water rights for surface irrigation in Wyoming are issued on the basis of 1 cfs of water per 70 acres of irrigated land. There are a total of approximately 87,100 acres of land covered by adjudicated water rights in the Greybull River Valley (Wyoming State Board of Control 1988). Of these, about 79,600 acres have diversion rights from the mainstem of the Wood River and the mainstem of the Greybull River. Total acreage actually irrigated from the Wood and Greybull rivers is approximately 62,464 acres, or 78 percent of the land with adjudicated water rights (GEI 1994a).

3.4 AIR QUALITY

Air quality was identified during the scoping process as a resource which may experience impacts from implementation of the project. Current air quality conditions in the project areas were evaluated

based on existing information and project evaluation. Because of the similar nature, location, industries, topographic features, and vegetation types of the two reservoir alternatives, air quality is considered together for both alternatives.

The primary air pollutant in Wyoming is total suspended particulates (TSP) (C. Collins, WDEQ/AQD, pers. commun.). Sources of TSP include wind blown dust and particles from natural sources such as exposed topsoil, surface mines, highway and other construction sites, unpaved roads, agriculture activity, fires, and other developments. Conditions such as dry windy periods increase TSP levels. Other conditions such as atmospheric stability, vertical air movement, and prevailing winds may increase the ability of air to disperse pollutants and lower TSP concentrations.

The Wyoming ambient air quality standard for particulate matter is 50 micrograms per cubic meter ($\mu g/m^3$) annual arithmetic mean or 150 $\mu g/m^3$ for a 24-hour average concentration with not more than one expected exceedence per year (WDEQ 1994). The nearest State and Local Air Monitoring Station (SLAMS) to the project area is in Cody, Wyoming, approximately 60 miles north. The annual arithmetic mean for particulate matter at this station for 1994 was 37.5 $\mu g/m^3$. During 1994 there was one exceedence of the 24-hour limit at the Cody station (WDEQ 1994).

The Greybull River Valley is located in the Bighorn Basin airshed, which is designated as a Prevention of Significant Deterioration (PSD) Class II area under WDEQ/AQD regulations (WDEQ 1989). Under this classification, areas may be developed with associated release of certain air pollutants provided that national air quality standards are maintained (WDEQ 1989). There are no PSD Class I areas, where little to no air quality pollution is allowed, in the Greybull Valley. The nearest Class I area is located in the Absaroka Wilderness Area, Shoshone National Forest approximately 40 miles west of the proposed reservoir site (BLM 1994).

The project areas are comprised primarily of agriculture land, cottonwood riparian zones along the Greybull River, and sagebrush rangeland/badlands. Air quality in the project areas is typical of rural areas and is considered generally good (BLM 1994). Primary sources of TSP that currently exist in the project areas include vehicular travel on dirt roads, farming practices in agricultural areas of the valley, and windblown dust from other sources. Other sources of air pollutants in the area include smoke from fires (for example, burning of agriculture fields and irrigation ditches); sulfur compounds associated with oil and gas development; and exhaust from vehicular traffic, agriculture equipment, and construction activity. There are no known Class II violations of air quality standards in the Greybull Valley (BLM 1994; C. Collins, WDEQ/AQD, pers. commun.).

3.5 NOISE

Noise was identified during the scoping process as a potential project impact. Current noise conditions in the project areas were evaluated based on existing information and project evaluation. Because of the similar nature, location, industries, topographic features, and vegetation types of the two alternatives, noise is considered together for both alternatives.

There are no known studies of ambient noise levels in the Greybull Valley (D. Ogaard, BLM, pers. commun.). Currently, noise in the Greybull Valley is typical of rural areas. Industry in the project area is composed primarily of agriculture and livestock operations. Sources of ambient noise throughout the area include agricultural and livestock operations (for example, farm equipment, cattle herding) in the valley, intermittent vehicular traffic on roads, seasonal construction activity, and natural sources (for example, wildlife, wind, river water). Noise heard during site visits emanated primarily from natural sources such as wind, water flowing in the Greybull River, weather disturbances, and wildlife. Other sources of ambient noise heard include vehicular traffic, farming equipment, cattle, and occasional aircraft. Because the project sites and surrounding areas are rural and sparsely populated and sources of loud noises few, ambient noise levels are likely to be between 40 and 50 dBA under calm wind conditions. These noise levels are similar to those experienced in libraries or residential living rooms and are characterized as being very quiet.

3.6 BIOLOGICAL RESOURCES

3.6.1 WETLANDS

Wetlands are valuable and sensitive areas. They provide resting, feeding, nesting, and brooding habitat for a variety of fish and wildlife; function in water quality enhancement by filtering pollutants and sediments from runoff; and provide protection from erosion and store flood waters. This unique combination of functional values is important to man and is acknowledged by their CWA classification as special aquatic sites. As such, they are afforded an extra measure of protection.

Due to the proximity of the Greybull River and Dry Creek, abundance of irrigation canals, and irrigation practices, numerous wetlands are scattered throughout the irrigated lands of the Greybull Valley. Both the Greybull River and Dry Creek corridors contain palustrine and riverine wetlands (USFWS 1993a). Additionally, numerous palustrine wetlands exist along irrigation canals throughout the valley due to seepage and numerous wetlands exist as a result of irrigation practices.

A preliminary wetland investigation was made at several alternative reservoir sites for use in the alternatives screening process (WEST 1995b). Detailed wetland delineations were conducted for the two reservoir alternatives during the summer of 1996 (WEST 1996c). The wetland information presented here is based on the latter investigations. Additional supporting information was taken from USFWS National Wetland Inventory (NWI) maps (USFWS 1993a). Dominant plant species found in the wetlands and plant communities (Section 3.6.2.1) are listed in Appendix B.

<u>Lower Roach Gulch Alternative</u>

There is one palustrine wetland located within the reservoir site. This wetland is an approximately 1.8 acre stock pond dominated by foxtail barley, sandbar willow, tamarisk, and plains cottonwood (Appendix B). There are scattered areas within three of the plant communities of the Lower Roach Gulch Alternative (mixed riparian shrub-shrub steppe, willow riparian shrub, and cottonwood

riparian, see Section 3.6.2 VEGETATION) which have wetland vegetation. The intermittent streambed of the gulch, including the outflow route, could be classified as mixed riparian shrub-shrub steppe. Approximately 0.93 acre of this community supports plant communities dominated by wetland vegetation including baltic rush, inland saltgrass, sandbar willow, and alkali cordgrass. Willow riparian shrub and scattered areas of palustrine emergent vegetation along the canal route are dominated by wetland vegetation. These areas total approximately 0.28 acre and are dominated by sandbar willow, smooth scouringrush, narrowleaf cottonwood, baltic rush, and foxtail barley (Appendix B). There are scattered areas of predominantly wetland vegetation along the cottonwood riparian corridor of the Greybull River. These are classified primarily as palustrine emergent, shrub, and forested areas (USFWS 1993a). There are also scattered areas of lower perennial riverine habitat and slightly vegetated gravel bars (USFWS 1993a). Based on the wetland delineations, approximately 165.43 acres of the 6.2-mile riparian corridor between the diversion point and return flow point may be considered wetland.

Blackstone Gulch Alternative

Three stock ponds are located within the reservoir site at Blackstone Gulch totaling approximately 2.2 acres. Wetlands around these stock ponds total approximately 0.51 acre (WEST 1996c). The larger pond was built by the BLM in 1983 and is called "Friday the 13th Reservoir". In 1992, the BLM conducted a wetland and wildlife enhancement project at this pond by constructing a second dam upstream of the first and fencing the new impoundment. Consequently, extensive wetland vegetation has grown around the margins of the pond. Dominant plant species include foxtail barley, baltic rush, fowl bluegrass, baltic rush, Nebraska sedge, and narrowleaf cottonwood (Appendix B). The smaller stock ponds support similar vegetation, however, these ponds are not fenced. Vegetation around these ponds has been grazed by livestock and big game. The intermittent streambed of Blackstone Gulch could be classified as mixed riparian shrub-shrub steppe. Approximately 0.04 acre within this community supports monotypic stands of sandbar willow or plains cottonwood. There are approximately 0.02 acre of wetland along the return flow route which is dominated by sandbar willow, baltic rush, and barnyard grass (Appendix B). Scattered areas of predominantly wetland vegetation occur along the cottonwood riparian corridor of the Greybull River. These are classified primarily as palustrine emergent, shrub, and forested areas. There are also scattered areas of lower perennial riverine habitat and slightly vegetated gravel bars (USFWS 1993a). Based on wetland delineations, approximately 79.75 acres of the 3.9-mile riparian corridor between the diversion and return flow points may be considered wetland.

3.6.2 VEGETATION

Vegetation at both sites was mapped using aerial photographs, topographic maps, and ground surveys. For each alternative, plant communities were mapped for the reservoir site, the diversion dam and intake canal, the outlet channel, and the river corridor between the diversion and point of return flow. Five major plant communities occur within the Lower Roach Gulch and Blackstone Gulch project areas. These communities were mapped on NWI and USGS topographic maps and total acreage occupied by each community was calculated using a calibrated digitizer. These areas

were supplemented with measures made during ground surveys. Refer to Appendix B for a list of the dominant plant species within each community.

3.6.2.1 Plant Communities

Lower Roach Gulch Alternative

Five major plant communities occur within the project area: mixed grassland-sagebrush shrubland, mixed riparian shrub-shrub steppe, willow riparian shrub, cottonwood riparian, and palustrine wetland (Figure 3.6). Wetlands have been discussed above. In addition to plant communities, rocky outcrops and ridges with sparse vegetation' prevail throughout the reservoir site.

The mixed grassland-sagebrush shrubland plant community occupies approximately 551 acres of the total project area and occurs primarily within the reservoir site in areas of moderately steep to flat slope and along the canal route primarily in areas outside the Greybull River floodplain. The mixed riparian shrub-shrub steppe community occupies approximately 19 acres of the total project area and occurs primarily within the reservoir site along the intermittently flooded stream bed within the gulch and along the outflow channel for return flows to the Greybull River. The cottonwood riparian community occurs along the Greybull River between the point of diversion and the return flows for the project. This plant community is comprised of a variety of smaller communities based on dominant vegetation in specific areas, but was treated as one community for environmental description purposes. The willow riparian shrub community occurs primarily within the cottonwood riparian community along the Greybull River. There are approximately 232 acres of cottonwood riparian and willow riparian shrub in the project area. Rocky outcrops and ridges scattered throughout the reservoir site occupy approximately 105 acres. These areas consist of exposed rock and soil with little vegetation; however, they provide unique habitat features important to wildlife.

Blackstone Gulch Alternative

Five major plant communities occur within the Blackstone Gulch project area: mixed grassland-sagebrush shrubland, mixed riparian shrub-shrub steppe, willow riparian shrub, cottonwood riparian, and palustrine wetland (Figure 3.7). Wetlands are discussed above. In addition to plant communities, rocky outcrops and bare ridges prevail throughout the reservoir site.

Figure 3.6 Map of vegetation communities at the Lower Roach Gulch Alternative.

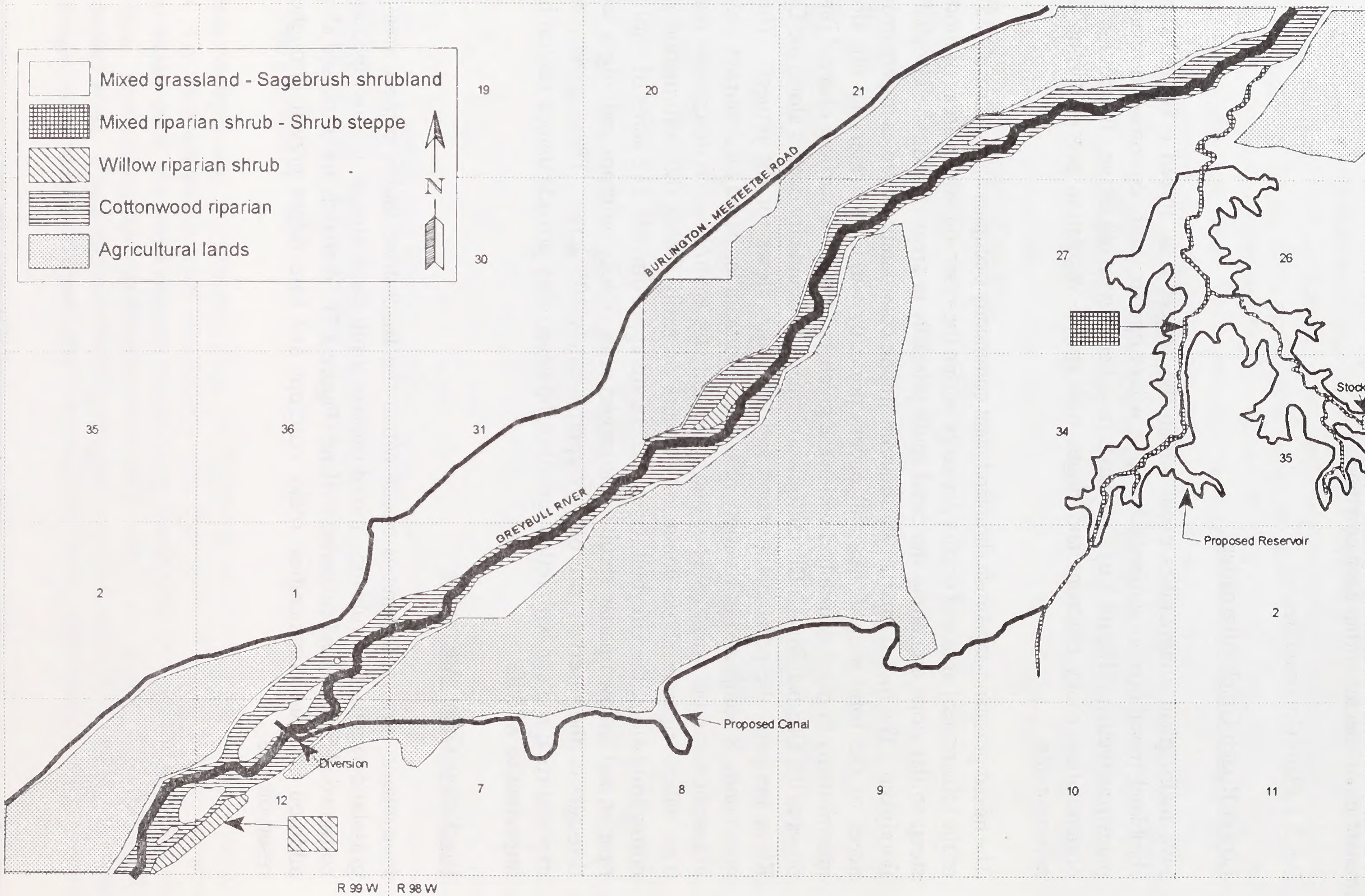
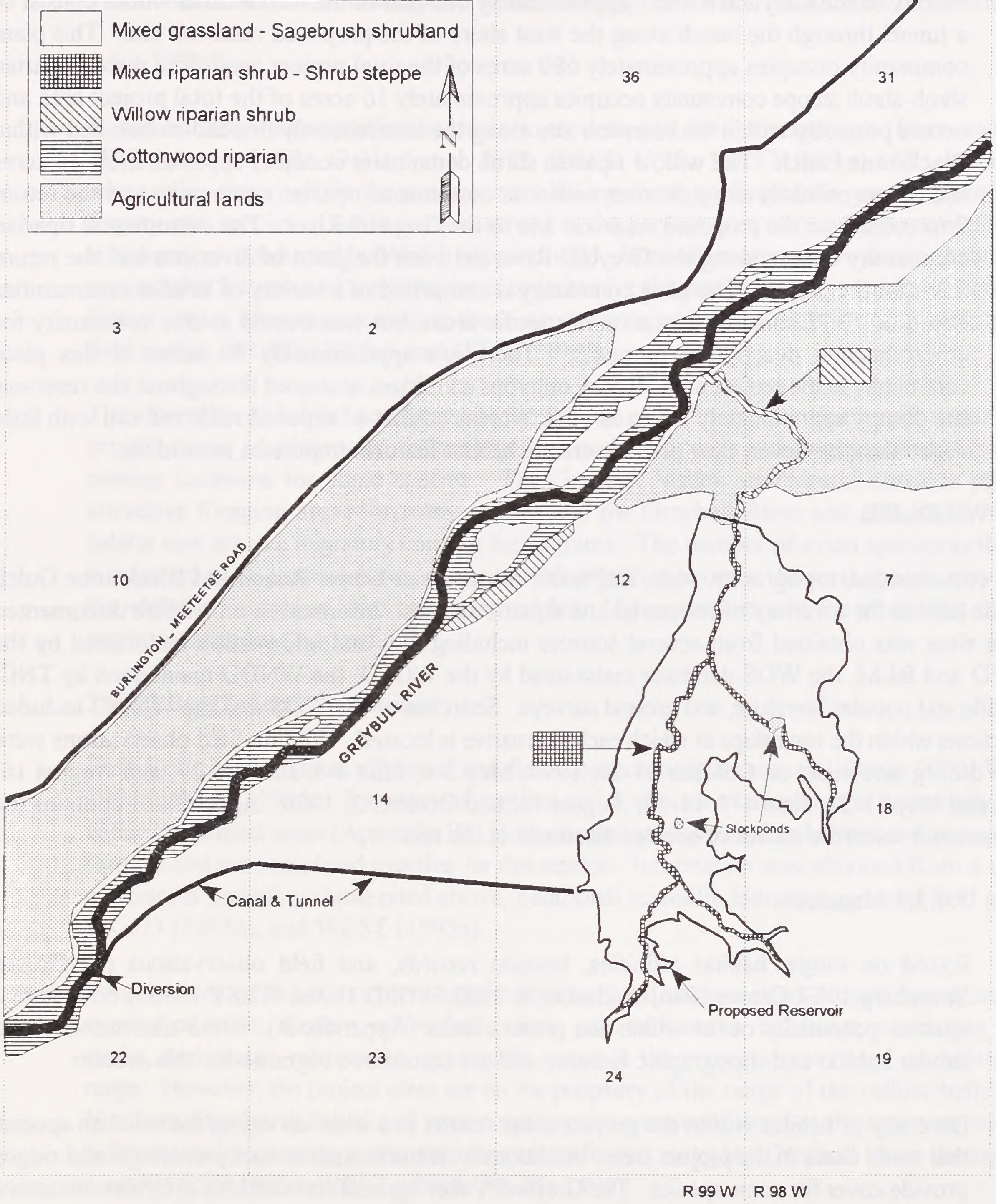


Figure 3.7 Map of vegetation communities at the Blackstone Gulch Alternative.



The mixed grassland-sagebrush shrubland plant communities occur primarily within the reservoir site in areas of moderately steep to flat slope and along the intake canal in the vicinity of the Greybull River. Approximately one-half of the intake canal would consist of a tunnel through the bench along the west shore of the proposed reservoir site. This plant community occupies approximately 680 acres of the total project area. The mixed riparian shrub-shrub steppe community occupies approximately 16 acres of the total project area and occurs primarily within the reservoir site along the intermittently flooded stream bed within Blackstone Gulch. The willow riparian shrub community occupies approximately 10 acres and occurs primarily along the river within the cottonwood riparian community and the return flow route from the proposed reservoir site to the Greybull River. The cottonwood riparian community occurs along the Greybull River between the point of diversion and the return flows for the project. This plant community is comprised of a variety of smaller communities based on the dominant vegetation in specific areas, but was treated as one community for environmental description purposes. There are approximately 80 acres of this plant community in the project area. Rocky outcrops and ridges scattered throughout the reservoir site occupy approximately 34 acres. These areas consist of exposed rock and soil with little vegetation; however, they provide unique habitat features important to wildlife.

3.6.3 WILDLIFE

Plant communities, topography, soils, and water resources at Lower Roach and Blackstone Gulch provide habitat for a variety of terrestrial and aquatic species. Information on wildlife documented at the sites was obtained from several sources including files and information maintained by the WGFD and BLM, the WOS database maintained by the WGFD, the WNDD maintained by TNC, scientific and popular literature, and ground surveys. Searches of the WOS and the WNDD included all sections within the townships in which each alternative is located. Wildlife field observations were made during site visits on October 25-26, 1994; May 3-4, June 4-5, June 26-27, and August 16, 1995; and May 21-22, June 4-7, 11-12, August 13, and October 2, 1996. Appendix B contains the common and scientific names of species discussed in the text.

3.6.3.1 Mammals

Based on range, habitat affinities, historic records, and field observations (Clark and Stromberg 1987, Crowe 1986, Oakleaf et al. 1992, WGFD 1995a, WEST 1995a) 66 mammal species potentially occur within the project areas (Appendix B). Both alternatives have similar habitat and topographic features and are considered together for this section.

Diversity of habitat within the project areas results in a wide variety of mammalian species that could occur in the project areas. Additionally, features such as rocky outcrops and ridges provide cover for some species. The Greybull Valley agricultural corridor provides attractive foraging areas for many species. Populations of some species such as mule deer may increase during winter as animals move from higher elevations to the river valley in the project areas. Other species such as bats may migrate through or leave the area during winter.

Big game and prairie dogs were identified during scoping as species of special interest and are considered in more detail below. Several mammals that potentially occur in the area are listed under the ESA as endangered or candidate species and are also considered below.

3.6.3.2 Birds

Based on range, habitat affinities, historic records, and field observations (Dorn and Dorn 1990, Johnsgard 1986, Oakleaf et al. 1992, WGFD 1995a, WEST 1995a) 242 avian species potentially occur within the project areas during some portion of the year (Appendix B). Eighty-one species of birds were observed in the project area during field reconnaissance investigations conducted by WEST (Appendix B). Both alternatives have similar habitat and topographic features and are considered together for this section. Information was obtained from a variety of sources including those cited above, additional scientific literature, general field guides, WGFD (1995a), and WEST (1995a).

The diversity of habitat results in a wide variety of avian species that could occur in the project areas. Additionally, features such as rocky outcrops and ridges provide cover and nesting locations for some species. The Greybull Valley agricultural corridor provides attractive foraging areas for many species and the Greybull River and associated riparian habitat may act as a migratory corridor for migrants. The number of avian species in the area is expected to be greatest during spring and fall migration periods. Several species may spend the winter in the project areas having moved from higher elevations in the mountains or more northern latitudes (Appendix B).

3.6.3.3 Reptiles and Amphibians

Based on range, habitat affinities, and field observations (Baxter and Stone 1980, WGFD 1995a, WEST 1995a) 7 species of reptiles and 5 species of amphibians potentially occur within the project areas (Appendix B). Both alternatives have similar habitat and topographic features and are considered together for this section. Information was obtained from a variety of sources including those cited above, additional scientific literature, general field guides, WGFD (1995a), and WEST (1995a).

Two species of lizard, northern sagebrush lizard and eastern short-horned lizard, and five species of snake, eastern yellow-belly racer, pale milk snake, bullsnake, wandering garter snake, and prairie rattlesnake, potentially occur in the project areas based on habitat and range. However, the project areas are on the periphery of the range of the yellow-belly racer. Northern Sagebrush lizard and prairie rattlesnake were confirmed at the reservoir site, and bullsnake and wandering garter snake were confirmed along the Greybull River through site visits (WEST 1995a, WEST 1996d, WGFD 1990).

The tiger salamander, plains spadefoot, Woodhouse's toad, northern leopard frog, and boreal chorus frog potentially occur in the project areas based on known ranges. These species

would be tied to the wetlands and Greybull River due to life history requirements. Woodhouse's toad and northern leopard frog were observed along the Greybull River while conducting wetland delineations (WEST 1996d).

3.6.4 AQUATIC RESOURCES

3.6.4.1 Fisheries

Downstream of Meeteetse, the Greybull River supports a limited game fish population. The WGFD manages this segment of the Greybull River as a natural recruitment fishery for yellowstone cutthroat trout and mountain whitefish that has been supplemented in the past with occasional stocks of trout. Yellowstone cutthroat trout are not afforded any special management status within the Greybull River Valley. The last recorded stocking downstream of Meeteetse was in 1974, when 13,245 sub-catchable Snake River cutthroat trout were planted. No stocking has occurred downstream of Meeteetse since this period. Because this segment of the river is bounded by private property on both banks, with limited public fishing access, little fish population and angler return creel census data are available.

The portion of the Greybull River below the confluence with the Wood River has been designated as a Class 2 fishery, which is defined as water that (1) presently supports game fish, (2) has the hydrologic and natural water quality potential to support game fish, and (3) includes nursery areas of food sources for game fish (WGFD 1987). Other than the Yellowstone cutthroat trout and mountain whitefish, thirteen other species of fish have been reported in the Greybull River downstream of Meeteetse (Appendix B). Of these, game fish included walleye, channel catfish, brown trout, and Snake River cutthroat trout.

Fish species collected by the WEST Team (1996a) in the lower section of the Greybull River included longnose dace, flathead chub, plains killifish, white sucker, an unknown shiner species, creek chub, longnose sucker, stonecat, and mountain whitefish.

The two action alternatives are similar in scope, size, and location within the valley. Generally, these alternatives may affect two reaches of the Greybull River, (1) the reach between the diversion dam and the reservoir discharge, and (2) the reach between the reservoir discharge and the Greybull-Bighorn River confluence.

Greybull River Downstream of the Diversion Dam

Based on data collected from a sample site during an instream flow study by Zafft and Annear (1992) of the WGFD, the Greybull River downstream of the proposed diversion dam for Lower Roach Gulch was characterized as a very low gradient (less than 0.5 percent), highly braided stream with limited deep pool habitat. At the study site, the abundance of game fish, estimated at 544 mountain whitefish and 18 yellowstone cutthroat trout per mile, was less than half of that reported for an upstream site (Zaft and Annear 1992). More abundant pool

habitat in the upstream reach was considered the primary reason for the greater fish density. Their study did not evaluate chemical water quality; however, water quality does not appear to be a limiting factor for these game fish. Physical characteristics such as shallow depth, high summer temperatures, reduced flow, heavy sediment loads, and general lack of habitat appear to be the primary factors causing low numbers of game fish (Zafft and Annear 1992).

Downstream of the Reservoir Discharge

Zafft and Annear (1992) described the lower 33 miles of the Greybull River (Farmer's Ditch to the Bighorn River) as particularly degraded habitat for fisheries and other aquatic life, with numerous irrigation withdrawals, extreme day to day discharge fluctuations, and eroding banks. The lower section is often severely dewatered for irrigation between July and October. During late summer periods of extremely low flow, most of the flow is irrigation return flow. As a result, high turbidity and high stream temperatures may limit survival and production of trout in this section of river. No fish data are available for the segment of the river between the proposed reservoir discharge site and the town of Otto.

Studies on the lower 12 miles of the Greybull River between the State Highway 30 Bridge crossing east of Otto and the Greybull-Bighorn River confluence provide an up to date and similar description of the Greybull River (WEST 1996b). Within the lower 12 river miles, the Greybull River flows through a highly braided channel. Water depths are shallow and banks are actively eroding. Occasional pools exist, often as the result of crudely constructed irrigation diversions or natural channel constriction. The river bottom is typically cobble or gravel, which is moderately embedded with finer clays and silts. Fine sediment in the river is readily mobile, but the river apparently lacks sufficient flows to mobilize it.

Low water velocities and abundant sediment deposits provide conditions for abundant periphytic algal growth; however, no aquatic macrophytes were observed. The average slope of the lower reach, calculated using USGS 7.5 minute quadrangles, equaled 0.0033, indicating a very low gradient. According to Rosgen's (1994) channel classification system, the lower Greybull River is a D-3 or D-4 type channel, characterized as having a wide, braided channel with longitudinal and transverse bars, eroding banks, and low gradient. Irrigation withdrawals and returns are frequent in this reach of the river. The largest irrigation water return is the Bighorn Canal, which enters the Greybull River approximately 2.3 river miles upstream of the Greybull-Bighorn River confluence.

The Bighorn River downstream of Worland is characteristic of a warm water fishery because of higher water temperatures and lower dissolved oxygen. Irrigation return flows contribute to increases in water temperatures, suspended solids, dissolved solids, and lower dissolved oxygen (Annear and Braaten 1995). WGFD data from 1985 indicated that sauger, walleye, and channel catfish were the predominant sportfish in the lower Bighorn River, comprising 40, 31, and 15 percent, respectively, of the gamefish collected. Fisheries surveys conducted by the WGFD between 1981-1985 indicate the following additional species also are found in

the lower Bighorn River: brown trout, carp, ling, rainbow trout, river carpsucker, white sucker, longnose sucker, redhorse sucker, and flathead chub (WGFD 1982-1986).

The WGFD is reintroducing shovelnose sturgeon into the lower Bighorn River (Annear and Braaten 1995). The environmental assessment for the reintroduction plan reports that the lower Bighorn River would provide suitable habitat for all life stages of the shovelnose sturgeon. Planned reintroduction during 1995 was delayed due to poor hatching and survival at the fish hatchery which was supplying the shovelnose sturgeon stock (Obrecht 1995); however, reintroduction efforts began in July, 1996 (T. Annear, WGFD, pers. commun.)

3.6.4.2 Invertebrate Community

Only scant qualitative data are available on benthic macroinvertebrate communities in the lower Greybull River. During the spring 1995 sturgeon chub studies, rocks were turned and examined. Mayfly, blackfly, and caddisfly taxa were observed on several stones at several locations in the Greybull River. A kick net sample collected during the fall 1995 sturgeon chub studies contained approximately three families of mayfly, two families of caddisfly, two to three families of stonefly, five or more families of midges, and at least one family of beetle. Annear and Braaten (1995) reported that macroinvertebrates in the lower Greybull River ranged from 100 to 250 organisms/ft^2. While these data are sparse, they fall within the range of macroinvertebrate densities reported by Pennak (1977) for 19 Rocky Mountain streams.

3.6.5 SPECIES OF SPECIAL INTEREST

Species of special interest identified during the scoping process for this EIS included prairie dogs, raptors, waterfowl, big game, and upland game birds. Each group is considered below.

3.6.5.1 Prairie Dogs

Black-tailed and white-tailed prairie dog potentially occur in the project areas (Clark and Stromberg 1987). Prairie dogs are of interest because they provide habitat and prey for a variety of species including the endangered black-footed ferret which requires prairie dog colonies for its existence. The last known wild population of black-footed ferrets was found on the Pitchfork Ranch in 1981, located approximately 20 miles west of the Blackstone Gulch Alternative.

No prairie dog colonies occur in the Lower Roach Gulch or Blackstone Gulch project areas (WEST 1995a). Ground surveys were conducted on June 4 and 5, 1995 to search for prairie dog colonies at the reservoir sites, along the intake canal routes and outflow channels, and at proposed borrow sites. The Greybull River corridor between the diversion point and return flow points, primarily cottonwood riparian and wetland habitats, does not provide suitable habitat for prairie dogs.

3.6.5.2 Raptors

A variety of hawks, falcons, and owls potentially occur in the project areas based on range and habitat affinities. Both alternatives have similar habitat and topographic features and are considered together for this section. Results of site visits and database searches are presented separately for each alternative. Information was obtained from a variety of sources including Dorn and Dorn (1990), Johnsgard (1986), Oakleaf et al. (1992), WGFD (1990, 1995a), and WEST (1995a).

Thirteen species of hawks and eagles potentially occur in the project areas, including turkey vulture, osprey, bald eagle, northern harrier, sharp-shinned hawk, Cooper's hawk, northern goshawk, broad-winged hawk, Swainson's hawk, red-tailed hawk, ferruginous hawk, rough-legged hawk, and golden eagle. All of these potentially breed in the area with the exception of northern goshawk, broad-winged hawk, and rough-legged hawk, which would be potential migrants or winter residents in the project areas. Bald eagle, northern goshawk, and ferruginous hawk, federally listed species, are considered in more detail below.

American kestrel, merlin, and prairie falcon potentially occur in the project areas as breeding residents. The peregrine or gyrfalcon may occur as migrants or rare winter visitors. Peregrine falcon, an endangered species, is considered in more detail below.

Owls which may breed in the area include barn owl, eastern screech owl, western screech owl, great horned owl, burrowing owl, long-eared owl, short-eared owl, and northern saw-whet owl. Snowy owl may be considered a rare winter visitor to the area. Burrowing owl, a candidate species, will be considered in more detail below.

Lower Roach Gulch Alternative

Nine species of raptors were documented in the project area during site visits (WGFD 1990, WEST 1995a, WEST 1996d) and as observations listed in the WOS or WNDD (WGFD 1995a, TNC 1995), including bald eagle, golden eagle, red-tailed hawk, Swainson's hawk, ferruginous hawk, Cooper's hawk, American kestrel, prairie falcon and great horned owl. Bald eagle, a threatened species, is considered in more detail below. Golden eagle, ferruginous hawk, American kestrel, and prairie falcon have been documented nesting in the project area.

The WGFD has records of two golden eagle nests along the Greybull River between the proposed diversion and return flow point in the WOS (WGFD 1995a). In 1990, a WGFD biologist observed a brood of recently fledged ferruginous hawks along the proposed canal route to the reservoir (WGFD 1990). No nest could be located for this brood. One active American kestrel aerie was located within the reservoir site in early June 1995 (WEST 1995a). The aerie was within a cavity on a large rocky bluff in an area that would be

inundated by water. In 1990, a WGFD biologist located an active prairie falcon aerie in the reservoir site (WGFD 1990); this aerie was inactive in 1995 (WEST 1995a).

Blackstone Gulch Alternative

Bald eagle, golden eagle, Swainson's hawk, red-tailed hawk, rough-legged hawk, American kestrel, and prairie falcon have been documented in the Blackstone Gulch project area either during site visits (WEST 1995a) or as observations listed in the WOS or WNDD (WGFD 1995a, TNC 1995). Bald eagle, a threatened species, is considered in more detail below. Golden eagles and American kestrels have been documented nesting in the project area (WGFD 1995a. WEST 1995a). An adult Swainson's hawk was observed at the reservoir site carrying a prey item (presumably to feed nestlings) toward the riparian habitat along the Greybull River; however, no nest was found (WEST 1995a).

Two golden eagle nests have been documented along the Greybull River in the project area. One nest is in the vicinity of the return flow channel (WGFD 1995a). This nest is also within the project area for the Lower Roach Gulch Alternative. A second golden eagle nest exists on the face of the cliff through which the tunnel would be drilled for the canal route to the reservoir. This nest was inactive in 1995; however, the landowner stated that it had been active in 1994 and for several years prior to that (WEST 1995a). An American kestrel aerie was located on this same cliff in a cavity behind another large stick nest of unknown species (WEST 1995a). Additionally, a third inactive raptor nest on this cliff was observed during a site visit in June 1995 (WEST 1995a). The species for the two other raptor nests are unknown but they are presumed to be alternate nests for the golden eagles that use this cliff.

3.6.5.3 Waterfowl and Waterfowl Habitat

A variety of ducks, geese and swans as well as sandhill cranes potentially occur in the project areas based on range and habitat affinities. Both alternatives have similar habitat and topographic features and are considered together for this section. Results of site visits and database searches and waterfowl habitat investigations are presented separately for each alternative. Information was obtained from a variety of sources including Dorn and Dorn (1990), Johnsgard (1986), Oakleaf et al. (1992), WGFD (1995a), and WEST (1995a).

Tundra and trumpeter swans potentially occur in the project area as migrants; neither species would be expected to breed in the area. Greater white-fronted goose, snow goose, and Canada goose potentially occur in the project areas. Of these, only Canada geese would be expected to breed in the project areas. The other two species are potential migrants through the area. Ross' goose may be a very rare migrant through the area probably occurring with migrant snow geese.

Species that potentially breed in the project areas include wood duck, mallard, green-winged teal, northern pintail, blue-winged teal, cinnamon teal, northern shoveler, gadwall, American

widgeon, canvasback, redhead, ring-necked duck, lesser scaup, common goldeneye, Barrow's goldeneye, bufflehead, common merganser, red-breasted merganser, and ruddy duck. Greater scaup and hooded merganser may migrate through the project areas.

Lower Roach Gulch Alternative

Canada geese have been observed in the agriculture fields during migration and may utilize the Greybull River as breeding, resting, or staging areas (WGFD 1995a, WEST 1995a). Sandhill cranes were commonly observed in agricultural fields and the riparian corridor along the Greybull River. Common merganser, blue-winged teal, northern shoveler, and mallard were observed along the Greybull River where they probably forage on fish, aquatic vegetation and aquatic invertebrates (WEST 1995a, 1996).

Waterfowl habitat within the project area is primarily confined to the Greybull River and it's associated wetlands. Agriculture lands throughout the valley provide attractive foraging habitat for some species of waterfowl such as Canada geese and mallard. The Greybull Valley with the river and associated agricultural lands may serve as a migratory corridor for some species of waterfowl. The stock pond located within the reservoir site provides some habitat for waterfowl; however, habitat is marginal due to the distance to other open water and condition of the pond itself. The pond is very shallow due to silt buildup.

Blackstone Gulch Alternative

Canada geese have been observed in the agriculture fields during migration and may utilize the Greybull River as breeding, resting, or staging areas (WGFD 1995a, WEST 1995a). A group of 20 Canada geese was observed on the "Friday the 13th Reservoir" stock pond at the Blackstone Gulch Reservoir site in October 1994 (WEST 1995a). Geese probably use this stock pond as a resting or staging area while feeding in the agriculture fields along the Greybull River during migration. Sandhill cranes were also commonly observed along the Greybull River near this alternative. A pair of wood ducks was observed in the vicinity of the proposed diversion dam in June 1995; however, breeding could not be confirmed (WEST 1995a). Green-winged teal, blue-winged teal, and northern shoveler were observed on "Friday the 13th Reservoir" during site visits. Mallards and common mergansers were observed along the Greybull River during site visits (WEST 1995a).

Waterfowl habitat within the Blackstone Gulch project area is primarily confined to the Greybull River and it's associated wetlands. Agriculture lands throughout the valley provide attractive foraging habitat for some species of waterfowl such as Canada geese and mallard. The Greybull Valley with the river and associated agricultural lands may serve as a migratory corridor for some species of waterfowl. Stock ponds located within the reservoir site probably provide some habitat for waterfowl. The two stock ponds are close together and within 2 miles of the Greybull River.

3.6.5.4 Big Game

Pronghorn, mule deer, and white-tailed deer occur within or adjacent to the Lower Roach Gulch and Blackstone Gulch project areas (Figures 3.8 and 3.9). Moose and elk may be rare visitors to the lower Greybull River Valley (WGFD 1995b) and will not be considered further in the EIS. Specific information by species and alternative site is provided below.

During the scoping process for this EIS concerns over effects on big game crucial habitat and migration routes were raised. The WGFD defines crucial habitat as any range or habitat component that determines whether a population maintains and reproduces itself at or above the WGFD population objective over the long term (WGFD n.d.). There is no big game crucial habitat in the project areas (WGFD 1995b). Migration routes are definable routes followed during seasonal movements year after year by a particular big game population. No migration routes within the project areas have been documented (WGFD 1995b).

Lower Roach Gulch Alternative

Pronghorn in the project area are part of the Fifteen Mile herd (WGFD 1995b). The proposed reservoir is located within an area classified as winter/yearlong range. According to the WGFD, winter/yearlong range indicates that a portion of a population uses this habitat yearlong, but during winter there is a significant influx of animals from other seasonal ranges. The WGFD population objective for this herd is 4,600 animals. The estimated population for 1994 was 4,268, 92.8 percent of the objective (WGFD 1994). The WOS contains five observations totaling 46 pronghorn in the project area, and pronghorn were documented along the canal route and within the reservoir area during site visits (WEST 1995a).

Mule deer in the project area are part of the Greybull River herd unit (WGFD 1995b). The proposed reservoir site is located within an area classified as yearlong range (Figure 3.8). According to the WGFD, yearlong range indicates that a population or a substantial portion of a population use this habitat yearlong. The WGFD population objective for this herd is 4,000 animals. The estimated population for 1994 was 3,600, or 90.0 percent of the population objective (WGFD 1994). The WOS contains seven records totaling 97 mule deer in the project area, and mule deer were documented within the reservoir area, along the canal route, return flow channel, and river corridor during site visits (WEST 1995a).

White-tailed deer in the project area are part of the Bighorn Basin herd unit (WGFD 1995b). The proposed reservoir site is located primarily in an area not classified as white-tailed deer range, however, the northern end of the reservoir site is within a corridor along the Greybull River classified as yearlong white-tailed deer range (Figure 3.8). The WGFD does not have population data on this herd unit, and no population objective has been set for the herd. Harvest in this herd unit was 686 animals in 1994 (WGFD 1994). The WOS contains 6 records of 48 white-tailed deer in the project area (WGFD 1995a), and white-tailed deer were observed along the Greybull River during site visits (WEST 1996d).

Figure 3.8 Map of wildlife use areas at the Lower Roach Gulch Alternative.

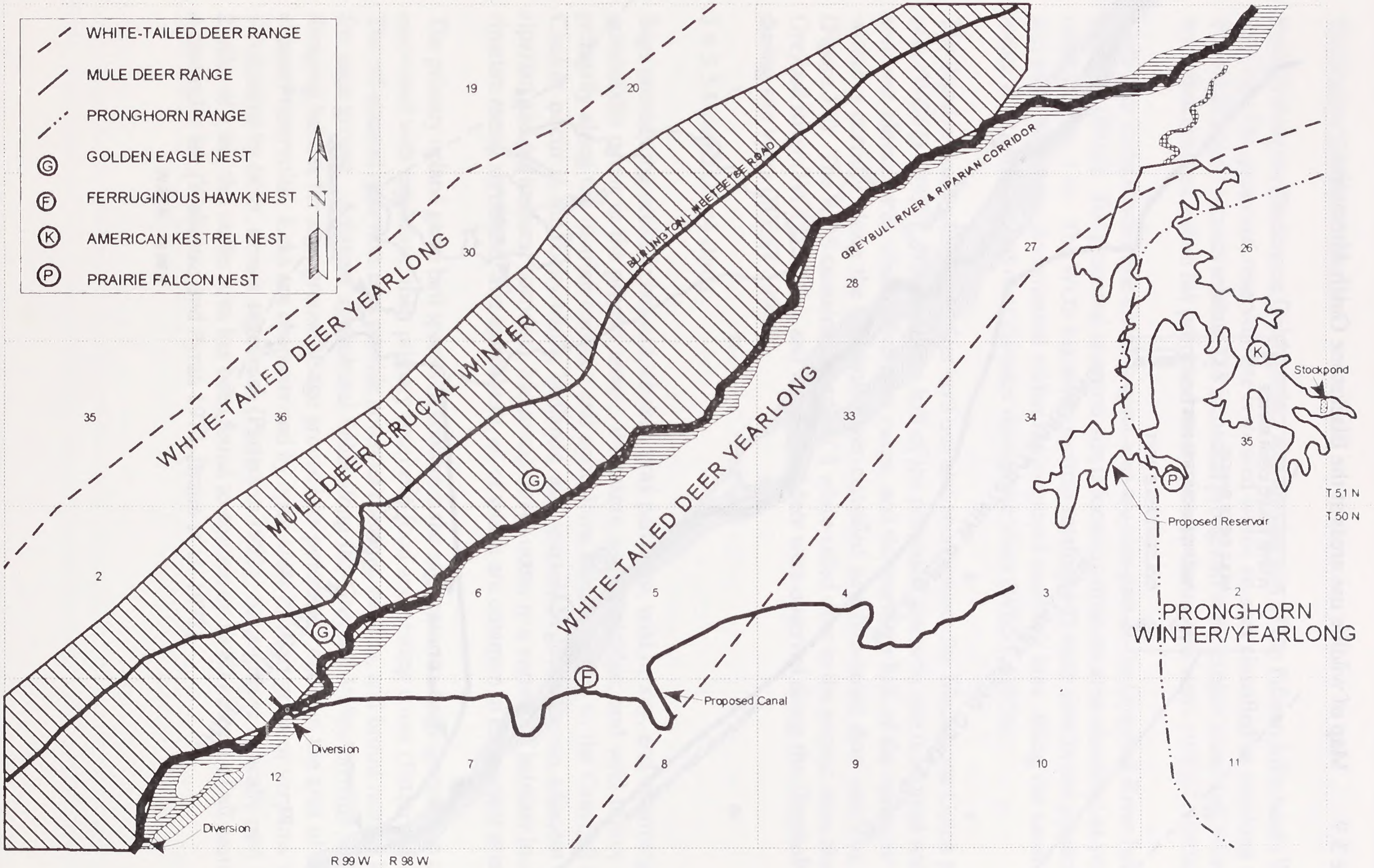
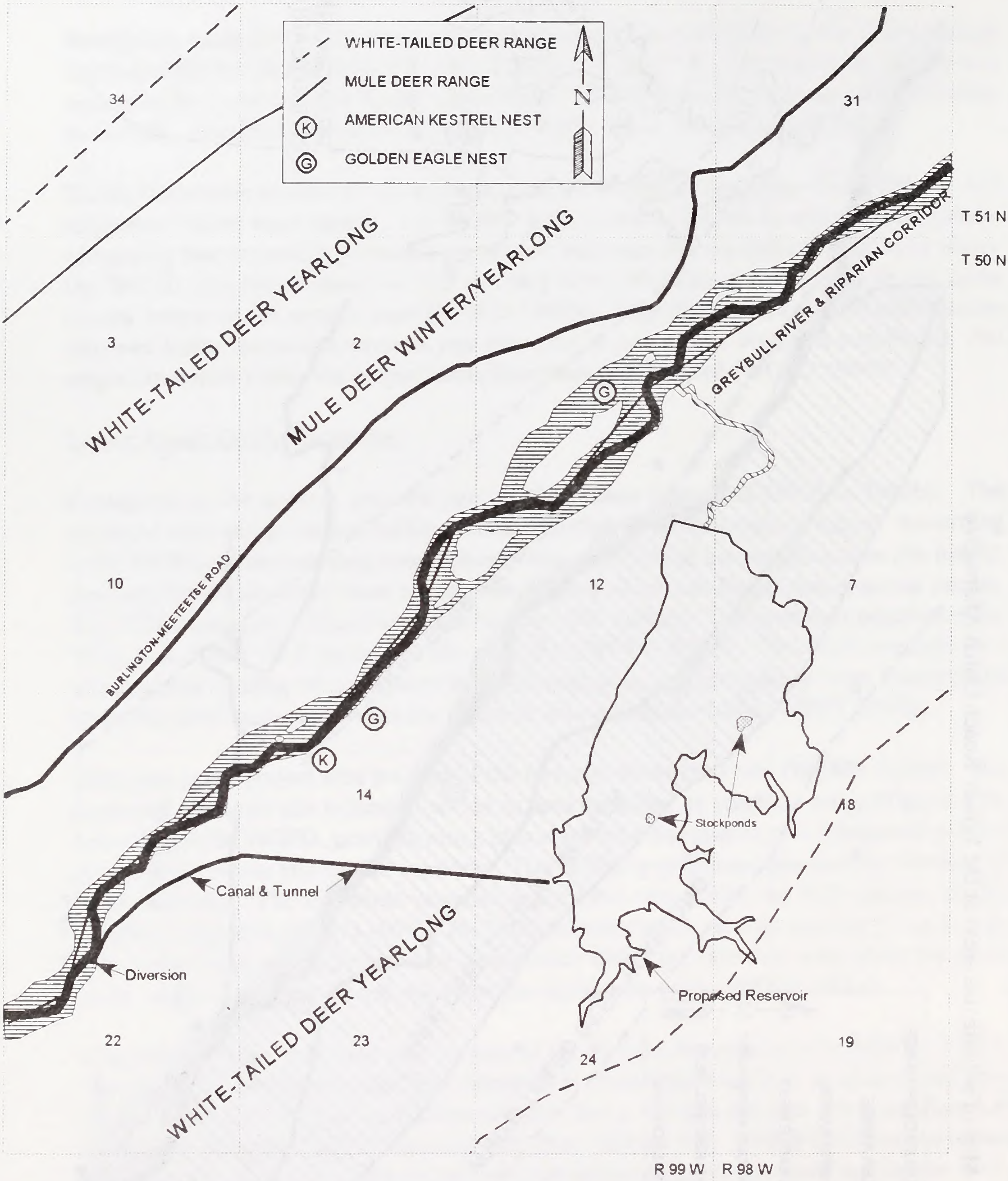


Figure 3.9 Map of wildlife use areas at the Blackstone Gulch Alternative



Blackstone Gulch Alternative

Pronghorn in the Blackstone Gulch project area are also part of the Fifteen Mile herd (WGFD 1995b). The proposed reservoir site is located within an area classified as yearlong range. The WOS has 13 records totaling 158 individual pronghorn in the project area, and pronghorn were documented within the proposed reservoir area during site visits (WEST 1995a).

Mule deer in the Blackstone Gulch project area are also part of the Greybull River herd unit (WGFD 1995b). The proposed reservoir site is located within an area classified as yearlong range (Figure 3.9). The WOS has seven records totaling 102 mule deer in the project area, and mule deer were documented within the proposed reservoir area, along the canal route, return flow channel, and river corridor during site visits (WEST 1995a).

The Bighorn Basin white-tailed deer herd unit also encompasses the Blackstone Gulch project area (WGFD 1995b). The southern half of the proposed reservoir site is located within an area not classified as white-tailed deer range, and the northern half of the reservoir site is within a corridor along the Greybull River classified as white-tailed deer yearlong range (Figure 3.9). The WOS contains records of 8 white-tailed deer in the project area along the Greybull River (WGFD 1995a), and white-tailed deer were observed along the Greybull River during site visits (WEST 1996d).

3.6.5.5 Upland Game Birds

Sage grouse, ring-necked pheasant, chukar, gray partridge, wild turkey, and mourning dove potentially occur in the project areas. Pheasants, gray partridge, and wild turkey occur primarily along the riparian corridor and agriculture fields adjacent to the Greybull River. Chukar occur in the rocky bluffs, badlands, and sparsely vegetated areas adjacent to the riparian and agricultural corridor. Mourning doves occur in a variety of habitats including riparian areas, shrubland, and agriculture, all of which are common in the project areas.

The primary upland game bird species of concern is the sage grouse. Sage grouse are closely associated with sagebrush, their primary source of food and nesting cover (Patterson 1952). The off-channel reservoirs sites provide potential roosting, nesting, and brood rearing habitat for sage grouse. Adjacent agricultural fields along the Greybull Valley provide attractive foraging habitat for sage grouse. Sage grouse leks potentially occur in the area of the off-channel reservoirs. Leks are characterized by open areas of short grass or very low shrubs surrounded by taller, denser sagebrush (Patterson 1952). Sage grouse typically nest within 2 miles of a lek; this buffer area has been found to contain up to 80 percent of all nests from a particular lek (Wallestad and Pyrah 1974, Braun et al. 1977).

Lower Roach Gulch Alternative

Lower Roach Gulch may provide roosting, nesting and brood rearing habitat for sage grouse. No leks were found during a survey for sage grouse leks conducted on May 3, 1995 at the reservoir site (WEST 1995a). The BLM has no records of sage grouse leks within 2 miles of the site (T. Stevens, BLM, per. commun.), and there is one observation of 6 sage grouse documented in the WOS in the reservoir site (WGFD 1995a). A flock of 6 sage grouse was observed flying into an alfalfa field approximately one mile north of the reservoir site and one sage grouse was flushed along the diversion canal route approximately one mile west of the reservoir site on October 2, 1996 (WEST 1996d).

Ring-necked pheasants were documented during site visits along the riparian corridor between the diversion and return flow point for this alternative. Mourning doves were documented throughout the project area (WEST 1995a). One flock of gray partridge was flushed along the diversion canal approximately one mile west of the reservoir site on October 2, 1996 (WEST 1996d). No wild turkey or chukar have been documented in the project area; however, the proper habitat types for these species occur in the area.

Blackstone Gulch Alternative

Blackstone Gulch may provide roosting, nesting and brood rearing habitat for sage grouse. No leks were found during a survey for sage grouse leks conducted on May 4, 1995 at the Blackstone Gulch Reservoir site (WEST 1995a). The BLM has records of two leks located approximately 1.5 miles south and 2.0 miles southwest of the southern end of the proposed reservoir site at Blackstone Gulch (T. Stevens, BLM, pers. commun.). Based on the 2 mile buffer, sage grouse from these leks could possibly nest within the area that would be inundated by water. There are no observations documented in the WOS for sage grouse at the Blackstone Gulch project area (WGFD 1995a). Sage grouse sign was documented in Blackstone Gulch at the reservoir site on October 26, 1995 (WEST 1995a), and a flock of sage grouse was observed flying into an alfalfa field approximately one-half mile east of Blackstone Gulch on October 2, 1996 (WEST 1996d).

Ring-necked pheasants were observed along the riparian corridor between the diversion and return flow point for this alternative during site visits. Mourning doves were documented throughout the project area (WEST 1995a). There is one observation of 14 chukar documented in the WOS at the Blackstone Gulch Reservoir site (WGFD 1995a). No wild turkey or gray partridge have been documented in the project area; however, the proper habitat types for these species occur in the area.

3.6.6 THREATENED, ENDANGERED, AND CANDIDATE SPECIES

A list of federally threatened, endangered and candidate species potentially occurring in the area was determined through informal consultation with the USFWS (Table 3.4). The bald eagle (threatened)

and peregrine falcon (endangered) are both potential migrants through the area. The endangered black-footed ferret is also a potential resident of prairie dog colonies in the area. There are no known threatened or endangered plant species in the project areas.

Table 3.4 Endangered, threatened, and candidate species which potentially occur or are known to occur in the project areas.

Species	Status[1]	Habitat	Occurrence
Mammals			
Black-footed Ferret	Endangered	prairie dog colonies	historical observations in latilong[2] of alternatives (Clark and Stromberg 1987)
Small-footed bat	Former category 2 candidate	sage steppe, shortgrass, rocky outcrops, caves, mines	observed in latilong of alternatives (Oakleaf et al. 1992)
Yuma bat	Former category 2 candidate	riparian areas, man-made structures	observed in latilong of alternatives (Oakleaf et al. 1992)
Long-legged bat	Former category 2 candidate	forests, shrublands, riparian areas	observed in latilong of alternatives (Oakleaf et al. 1992)
Long-eared bat	Former category 2 candidate	coniferous forest, cottonwood riparian	suspected breeder in latilong of alternatives (Oakleaf et al. 1992)1
Townsend's big-eared bat	Former category 2 candidate	desert shrubland, juniper woodlands, caves	suspected breeder in latilong of alternatives (Oakleaf et al. 1992)
Spotted bat	Former category 2 candidate	low desert, shrub-scrub, coniferous forest, open fields, canyon lands, cliffs	suspected breeder in latilong of alternatives (Oakleaf et al. 1992)
Birds			
Bald eagle	Threatened	coniferous forest, cottonwood riparian, water	one observation in LRG project area 3/30/85; one observation in BG project area 1/15/95 (WGFD 1995a)
Peregrine falcon	Endangered	cliffs near shorebird/ waterfowl habitat	suspected breeder in latilong of alternatives, expected migrant through area (Oakleaf et al. 1992)
Mountain plover	Candidate	shortgrass prairie, flat topography	breeder in latilong of alternatives (Oakleaf et al. 1992)
White-faced ibis	Former category 2 candidate	marshes, wet meadows	observed in Greybull Valley (WGFD 1995a)
Ferruginous hawk	Former category 2 candidate	sagebrush steppe, grasslands	breeder at LRG 6/13/90 (WGFD 1990), numerous observations in project areas (WGFD 1995a)

Species	Status[1]	Habitat	Occurrence
Loggerhead shrike	Former category 2 candidate	shrublands	breeder at LRG 6/5/95 (WEST 1995a); observed at BG 5/4/95 (WEST 1995a)
Western burrowing owl	Former category 2 candidate	shrublands, grasslands, agriculture	breeder in latilong of alternatives (Oakleaf et al. 1992)
Black tern	Former category 2 candidate	marshes, aquatic habitats	observed in latilong of alternatives (Oakleaf et al. 1992)
Long-billed curlew	Former category 3C candidate	grasslands, prairies, agriculture	observed in Greybull valley (WGFD 1995a)
Reptiles			
Eastern short-horned lizard	Former category 2 candidate	sagebrush, grasslands	no records, habitat suitable
Fish			
Sturgeon Chub	Candidate	highly turbid rivers	recorded near Big Horn Lake 1981 (WGFD data), no sturgeon chub found in GR (WEST 1996a)
Plants			
Persistent sepal yellowcress	Former category 2 candidate	mudflats, alkali beaches, sandy shores	one specimen at Schuster Flats 20 miles SE of alternatives (RMH 1995), no observations at alternatives

[1] Status = current or previous listing under ESA
[2] latilong = rectangle of 1 degree latitude and 1 degree longitude

3.6.6.1 Threatened and Endangered Species

The only threatened or endangered species expected to occur in the area based on current knowledge are bald eagle and peregrine falcon. Black-footed ferrets historically occurred in the area and the last known wild population of ferrets was found in the upper Greybull Valley. However, there are no prairie dog colonies, which black-footed ferrets require, within the project areas, precluding use of the area by this species (Hillman and Clark 1980).

There are 35 records of bald eagles along the Greybull River in the general vicinity of the alternatives. These records all occurred from October to April. It is assumed that these bald eagles were wintering in the area; however, there are no known winter concentrations in the Greybull Valley (B. Oakleaf, WGFD, pers. commun.). The only bald eagle documented within the Lower Roach Gulch project area was one sighting on 30 March 1985 in T. 51 N., R. 98 W., sec. 28, NE 1/4, which is located along the Greybull River approximately 1 mile west of the proposed reservoir site. There is also one record of a bald eagle in the Blackstone Gulch project area. This eagle was in T. 50 N. R. 99 W., sec. 12, SW1/4. This observation was made on 15 January 1982 along the Greybull River within 0.7 miles of the proposed

reservoir site. No observations of bald eagles were made during site visits to either of the project sites.

Although no peregrine falcons have been documented within the Greybull Valley in the vicinity of the alternatives, they are expected to migrate through the area (B. Oakleaf, WGFD, pers. commun.). There is circumstantial evidence that peregrine falcons breed in the latilong (a latilong represents a rectangle of 1 degree latitude and 1 degree longitude) of the project areas, but breeding has not been confirmed (Oakleaf et al. 1992). The riparian corridor of the Greybull River could provide foraging habitat for migrant peregrine falcons.

3.6.6.2 Candidate Species

The USFWS requests that Candidate species be considered during construction activities to protect them from further population declines. Prior to July 19, 1995, candidate species were defined by the USFWS as:

Category 1:	Federal T&E listing appears appropriate and is anticipated.
Category 2:	Current data are insufficient to support listing.
Category 3C:	More widespread or abundant than previously believed, or no immediate threats identified.

As of July 19, 1995, the USFWS Director issued new policy with respect to candidate species. Under the new policy, candidate species were redefined to mean only those species for which the USFWS has sufficient information indicating that listing may be appropriate. The new policy, therefore, considers only those species previously classified as a category 1 candidate. Despite this policy change, the USFWS continues to encourage protection of species previously classified as Category 2 candidate species. Therefore, this EIS addresses effects of the project on former Category 2 species as well as Category 1 species.

Based on location and habitat of the project area, the only candidate species under the new policy which may occur in the area are the mountain plover and sturgeon chub. Species previously considered Category 2 candidate species possibly occurring in the area include Allen's thirteen-lined ground squirrel, white-faced ibis, ferruginous hawk, western burrowing owl, black tern, loggerhead shrike, eastern short-horned lizard, Townsend's big-eared bat, spotted bat, small-footed bat, long-eared bat, long-legged bat, yuma bat, sturgeon chub, and persistent sepal yellowcress. The long-billed curlew, previously a Category 3C candidate species, also may occur in the project areas (Table 3.4).

Of the candidate species that potentially occur in the area, only ferruginous hawk and loggerhead shrike were documented at either project site. A brood of ferruginous hawks was noted along the canal route of the Lower Roach Gulch Alternative during a WGFD site visit in 1990 (WGFD 1990). No nest for this brood could be located at the time. During site visits

in 1995, loggerhead shrikes were seen at both reservoir sites and were documented breeding at Lower Roach Gulch within the area that would be inundated (WEST 1995a).

Mountain plover, although documented in areas nearby (WGFD 1995a), are not likely to occur in either project area due to lack of suitable habitat. White-faced ibis have been recorded in the Greybull Valley (WGFD 1995a) and may occur in suitable marshes along the river. Black terns may also occur at suitable marshes and wetlands along the river, but they have not been recorded in the area. Long-billed curlews have been documented in the Greybull Valley and are probably closely associated with agriculture fields (WGFD 1995a). Western burrowing owls have not been documented in the region (WGFD 1995a); however, suitable habitat exists throughout the Greybull Valley and at the alternative sites.

Suitable habitat exists at the reservoir sites for eastern short-horned lizards. However, there are no records of this species in the area and it was not recorded during site visits (WGFD 1995a, WEST 1995a).

Each of the bats listed (Table 3.4) occur in a variety of habitats, including those of the project areas. Little is known about distribution of bats in Wyoming and no records exist for these species in the project areas; however, all have been recorded in the latilong of the alternatives (Oakleaf et al. 1992).

The sturgeon chub potentially occurs in the Greybull River. Recently, it has been upgraded from a Category 2 to a Category 1 species (Federal Register 1994, USFWS 1993b). No records exist for sturgeon chub in the Greybull River. In the Bighorn Basin, the most recent collection of this species was near Big Horn Lake in 1981 (WGFD unpublished data), which is approximately 30 miles downstream of the Greybull-Bighorn River confluence. There have been no reports of sturgeon chub in the Bighorn Basin since 1981.

Studies in the spring and summer of 1995 on the lower Greybull River conducted by the WEST TEAM (1996a) indicated the following:

- No sturgeon chubs were collected from sites considered to be good sturgeon chub habitat based upon velocity, depth, and substrate measurements that were similar to those observed in other studies on rivers where sturgeon chubs were collected.
- The lower Greybull River supports populations of longnose dace and flathead chubs, species that occur in habitats similar to that of the sturgeon chub.
- The absence of sturgeon chubs may indicate that one or more obligate life requisites such as high turbidity, swift waters, or clean substrates may be missing or are not adequate in the lower Greybull River.

Other factors may singly or in combination contribute to the lack of sturgeon chub in these waters, including: (1) the Greybull River is at the edge of the natural range of this species, (2)

the Greybull River may be too small for sturgeon chub, and (3) large daily flow variations that occur during the irrigation season may be intolerable to the sturgeon chub.

With the exception of some historical records in Montana and some remaining occurrences in northern Canada, nearly the entire range of persistent sepal yellowcress is found in Wyoming near Boysen, Seminoe, and Buffalo Bill reservoirs and in the Bighorn Basin around small stock ponds. Persistent sepal yellowcress is typically found on mudflats where water levels fluctuate. Example habitats where specimens have been collected in Wyoming include exposed mudflats, alkali beaches, sandy slopes, and rocky shorelines adjacent to reservoirs; creek floodplains; sandy river banks and temporary ponds (Wyoming Herbarium Records, Univ. Wyoming). In Park County, this species has been collected along shorelines of Buffalo Bill Reservoir. Closer to the project area, there was a specimen collected near Schuster Flats in T. 48 N., R. 93 W., sec. 5 in association with a dry reservoir (RMH 1995). This site is located over 20 miles southeast of the project area. The most likely habitat for this species in the project area would be shorelines of stock ponds present on both alternative sites. These areas were surveyed for persistent sepal yellowcress in June 1995 and no individuals were located. No records of this species occur in the project areas in the WNDD.

3.6.6.3 Species of Concern in Wyoming

Species of concern in the State of Wyoming were determined through consultation with TNC and review of Garber (1991). TNC considers five species of amphibians, 15 species of reptiles, 86 species of birds, and 49 species of mammals to be species of special concern in Wyoming (Garber 1991). Species of concern not discussed above under other categories documented within a township buffer of the project areas include yellow-billed cuckoo, black-billed cuckoo, common loon, and small dropseed (Garber 1991). Both cuckoo species would likely be associated with the cottonwood riparian zone along the Greybull River. Common loons prefer large lakes and reservoirs and would not likely occur on either project site. Specimens of small dropseed have been collected in Park and Bighorn counties. Habitat of this species is dry barren or sandy soil (Hallsten et al. 1987) and disturbed areas (Dorn 1992). This habitat occurs within areas to be inundated by both reservoir alternatives; however, these areas were searched in June 1995 and no specimens were located.

3.7 LAND USE

There are approximately 1.02 million acres of land devoted to agricultural production in Big Horn and Park counties, of which 230,600 acres are irrigated (WDAI 1994). Non-irrigated lands are used almost exclusively for grazing. Limited and unpredictable rainfall in the area makes dryland crop production generally unprofitable (HDR 1988). Further detail regarding agricultural practices in the Greybull Valley are provided in Chapter 1.0.

3.7.1 CROPS AND CROPPING PATTERNS

Farming practices in the Greybull River Valley vary with elevation and water availability. Alfalfa and native hay crops are commonly grown at higher elevations and in areas where water supply for irrigation is unpredictable. In lower elevation areas served by water storage projects, cash crops such as small grains, dry beans, and sugar beets are common. The cropping patterns for Big Horn County include approximately 27 percent malt barley, 3 percent other small grains, 3 percent corn, 10 percent dry beans, 35 percent alfalfa and native hay, and 20 percent sugar beets (L. Craig, Big Horn County Conservation District, pers. commun.). Park County cropping patterns include approximately 20 percent malt barley, 5 percent other small grains, 8 percent corn, 8 percent dry beans, 50 percent alfalfa and native hay, and 14 percent sugar beets (D. Tranas, NRCS, pers. commun.).

Farmers and ranchers along the Wood and upper Greybull rivers primarily grow native hay and alfalfa crops. Farmers in the lower Greybull River Valley, below approximately 5,100 feet in elevation, grow a mixture of hay and cash crops. Based on a survey of the 226 GVID members served by the Farmers and Bench canals, GEI (1994a) characterized the average respondent as an irrigator of 350 acres with the majority of the land devoted to malt barley, sugar beet, dry bean, and alfalfa hay production. Malt barley was the most commonly grown crop (33 percent), followed by sugar beets and dry beans (22 percent each), alfalfa (17 percent), and other crops (6 percent). Typical per acre yields reported by the survey respondents were 42.6 hundred weight (cwt) for malt barley, 20.2 cwt for dry beans, 19.5 tons for sugar beets, and 4.2 tons for alfalfa. Sugar beet crops in the Emblem area result in good yields and some of the area's highest percentage sugar content (Table 3.5; D. Lindshield Western Sugar Company, pers. commun.).

Table 3.5 Sugar beet production and sugar content from Emblem and the Heart Mountain collection stations operated by Western Sugar, Lovell, Wyoming.

				Heart Mountain					
	Emblem			Ralston			Vocation		
Year	Percent Sugar	Tons/ Acre	Acres Harvested	Percent Sugar	Tons/ Acre	Acres Harvested	Percent Sugar	Tons/ Acre	Acres Harvested
1993	18.57	21.83	1,925	17.98	21.64	4,600			
1992	18.39	23.22	2,146	17.79	24.33	3,172	17.79	24.23	1,850
1991	16.67	18.09	1,865	15.41	20.03	3,254	15.97	19.56	1,822
1990	16.33	18.44	1,978	16.21	22.16	3,155	16.39	20.71	1,748
1989	17.35	14.80	1,181	16.93	22.00	2,829	17.27	21.00	1,505
1988	17.30	17.05	1,621	17.84	20.45	2,510	18.06	20.33	1,248
1987	18.07	21.06	1,548	17.51	22.82	2,353	17.80	22.57	1,293
1986	17.80	16.43	1,606	16.87	22.75	2,413	17.07	21.95	1,214
1985	16.70	18.64	1,642	16.65	22.86	2,265	16.42	20.98	1,273
Mean	17.47	18.84	1,724	17.03	22.12	2,951	17.10	21.42	1,495

3.7.2 CROP WATER REQUIREMENTS

The critical period for moisture when growing alfalfa is the seedling stage and immediately after cuttings. For top production, ample water is required throughout the growing season and fall irrigation is desirable (Cochran et al. 1992). The growing season for alfalfa in the project area extends from April through October and irrigation is required each month (Pochop et al. 1992). Peak irrigation requirements occur in June, July, and August (Table 3.6). The average consumptive irrigation requirement for alfalfa in the GVID is 32.22 inches/acre and the average storage requirement is 5.63 acre-feet/acre.

The critical water period for malt barley is from late sprouting through the early head stage (Cochran et al. 1992). Irrigation is required in the project area from April through July during all but the wettest years (Pochop et al. 1992; Table 3.6). The average consumptive irrigation requirement for malt barley in the GVID is 15.7 inches/acre and the average storage requirement is 3.26 acre-feet/acre.

The critical water periods for dry beans are early bloom and forming periods (Cochran et al. 1992). Once irrigation begins in June, water is required in all but the wettest years through September (Pochop et al. 1992; Table 3.6). Beans must receive water on a regular basis and a delay of even a few days can result in as much as a 50 percent crop loss (W. Smith, University of Wyoming Agricultural Field Station, Powell, Wyoming, pers. commun.). However, beans are very sensitive to over-irrigation (Cochran et al.1992), and too much water will cause root rot. The average consumptive irrigation requirement for dry beans in the GVID is 16.7 inches/acre and the average storage requirement is 2.92 acre-feet/acre.

Table 3.6 Total irrigation and diversion requirements for selected crops in the Greybull River Valley below 5100 feet elevation (present conditions).

	Acre-feet							
Crop	April	May	June	July	Aug	Sept	Oct	Total
Sugar Beets	2,947	1,364	3,982	8,322	7,436	3,614	0	27,665
Beans	0	0	1,533	7,845	6,550	687	0	16,615
Malt Barley	145	4,612	8,318	7,503	0	0	0	20,578
Alfalfa	1,888	3,120	3,932	5,557	4,494	2,220	596	21,807
Total	4,980	9,096	17,765	29,227	18,480	6,521	596	86,664
Diversion Requirements								
Crop	April	May	June	July	Aug	Sept	Oct	Total
Sugar Beets	6,180	2,860	8,351	17,454	15,596	7,579	0	58,020
Beans	0	0	3,215	16,452	13,738	1,414	0	34,846
Malt Barley	303	9,673	17,444	15,735	0	0	0	43,155
Alfalfa	3,960	6,544	8,247	11,654	9,425	4,656	1,249	45,735
Total	10,443	19,077	37,257	61,295	38,759	13,676	1,249	181,756

While sugar beets on average require water from April through September in the project area, the per plant spring requirements are lower than for alfalfa (Table 3.6). However, the actual spring irrigation required for sugar beets exceeds requirements for alfalfa. Spring irrigation is extremely important in arid areas where rainfall is absent or uncertain (Hagan et al. 1967). Fornstrom et al. (1978) found that in the Powell area, (1) final emergence of sugar beets was dictated by the lowest soil moisture reading during the emergence period, and (2) a final emergence of over 60 percent required a soil moisture content above 10.5 percent. To insure best germination of beets, Hagan et al. (1967) suggested that rainfall and irrigation should be adequate to bring the entire soil profile to field capacity (that is, the maximum amount of moisture the soil can hold) early in the growing season.

Beets can withstand considerable water stress during periods of growth but the last watering is critical to the production of a quality beet crop (W. Smith, University of Wyoming Agricultural Field Station, pers. commun.). A lack of fall water reduces sugar content, and thus the value of beets. The average consumptive irrigation requirement for sugar beets in the GVID is 24.83 inches/acre and the average storage requirement is 4.34 acre-feet/acre.

3.7.3 EXISTING IRRIGATION SYSTEM

Previous studies of water resources in the Greybull River Valley have indicated that average annual demand for water is approximately 370,000 acre-feet. The estimated annual shortage is approximately 61,000 acre-feet and the average available unappropriated water in the valley is about 70,000 acre-feet (HDR 1988). Modeling prepared by WEST (WEST 1996b) was used to estimate average annual demand, shortage, and unappropriated water along the mainstems of the Greybull and Wood rivers where storage in the existing reservoirs and the proposed reservoir could provide supplemental supplies. Current average annual demand for water along the mainstems determined using the WEST model is approximately 221,000 acre-feet while the annual shortage of water is about 8,540 acre-feet. Estimated average available unappropriated water is approximately 56,000 acre-feet. Unappropriated flows and diversion shortages occur in the valley for three reasons. First, unappropriated flows occur during the non-irrigation season when they are not needed for irrigation or cannot be diverted to a storage reservoir and are consequently passed downstream. Second, unappropriated flows may be entering reaches of the river downstream of the demands, either as tributary inflow or return flow from other irrigation diversions, and third, unappropriated flows may occur during peak runoff periods when all diversions are operating to capacity and still cannot divert all available flow.

There are over 88,000 acres of land permitted for irrigation in the Greybull River Valley, of which approximately 62,465 acres were irrigated in 1993 (GEI 1994a). Approximately half of the irrigated lands in the valley and in the GVID are served by the Farmers and Bench canals, which divert water from the lower Greybull River about 7 miles southwest of the Town of Burlington. Other irrigated land in the District is served by smaller diversion structures which divert from the river in the stretch from Meeteetse downstream to the mouth of the river south of Greybull, Wyoming. Approximately 1,211 acres on the Agrarian Bench along Dry Creek to the north of the Greybull River Valley receive an indirect water supply from the Greybull River. Return flows from irrigation on the Emblem Bench provide most of the water supply for these lands.

The GVID provides irrigation water to its members through operation of Upper and Lower Sunshine reservoirs, off-stream storage facilities located upstream from Meeteetse near the confluence of the Wood and Greybull rivers. The GVID built Upper Sunshine Reservoir in 1939 and Lower Sunshine Reservoir in 1972 to provide supplemental irrigation water to Greybull Valley irrigators. Both projects were funded by the sale of storage shares to District members (see Chapter 1.0).

Irrigation water releases from Upper and Lower Sunshine reservoirs are not able to consistently meet the needs of GVID irrigators. The reservoirs are generally operated to carry over enough water in storage at the end of the irrigation season to prevent catastrophic losses in the following irrigation season if water supplies are short. This operating plan is successful in preventing extensive losses in dry years as long as the drought lasts for only 1 year, but results in crop yield reductions almost every year. In most years, crops in the lower valley suffer a 10 to 20 percent yield reduction because of inadequate early and late season irrigation water supplies (Edwards 1994, see Chapter 1.0).

A survey of GVID members indicates that an average of approximately 20,000 acre-feet of additional irrigation water is needed annually to achieve full yield potential on the 33,500 acres served by the Farmers and Bench canal systems. Supplemental water is also needed for the 14,300 additional irrigated acres in the lower valley not served by the Farmers and Bench canals, as well as for the 14,700 irrigated acres in the upper valley. Modeling prepared by the WEST Team (WEST 1996b) indicates that overall needs in the valley average approximately 8,540 acre-feet annually, however, due to modeling limitations, the model does not take into account some sources of shortages such as icing of reservoir outlet channels. Actual demand is at least 20,000 acre-feet because individual farmers in the GVID have reserved in excess of 20,000 acre-feet of storage shares to date.

Under current conditions, it is difficult for the GVID to efficiently manage irrigation water releases from Upper and Lower Sunshine reservoirs. Chapter 1.0 provides detail on the present irrigation system and efficiency. Irrigation efficiency in the GVID increases with size and complexity of the irrigation water delivery systems in the Greybull River Valley (WEST 1996b). Ditches in the narrow upper valley are relatively small and provide little opportunity for capture of return flows for reuse. Irrigation efficiencies in the upper valley average approximately 40 percent. Ditches in the lower valley, while located in a wider valley, are also generally small which also limits the opportunities for recapture of return flows. Smaller ditches in the lower valley have irrigation efficiencies averaging approximately 43 percent. The Farmers and Bench Canal systems encompass an extensive network of laterals and ditches covering a broad area. Irrigation efficiency in these systems is approximately 50 percent. Several other factors also contribute to irrigation efficiency including irrigation practices, condition of irrigation structures and delivery canals, crop water requirements, precipitation and evaporation, and conveyance losses. Irrigated lands throughout the GVID are supplied with water through a network of primarily earthen canals and laterals. Seepage losses along these canals decrease irrigation efficiency, but also supply water to the alluvial aquifers and return flows for use by downstream irrigators.

Conveyance loss, the amount of water naturally lost between two points along a water course, along the Greybull River was studied by Lewallen (1994). Due to the distance between the current

irrigation storage sites (Upper and Lower Sunshine reservoirs) and primary diversions for irrigation (Farmers and Bench canals), conveyance losses are high. Lewallen (1994) found that between the USGS water monitoring station at Meeteetse and the diversion for the Farmers and Bench canals, total average conveyance loss over the summer months (July to September) for a 1 day period equaled approximately 14 percent. For example, at flows of 600 cfs an average loss of 88.38 cfs per day was attributed to conveyance. Generally speaking, conveyance losses in the Greybull River rose at a relatively constant rate to 200 cfs at river flows of 1,650 cfs but began to level off at higher river flows (Lewallen 1994). Conveyance losses generally consist of three components: evaporation, consumptive use by riparian vegetation, and seepage. Seepage is generally the largest component and results in recharge of the alluvial aquifers. This water is held in storage in the aquifers (bank storage) until the river level drops and the water table gradient allows it to return to the stream. In desert environments, such as the lower Greybull River Valley, return of bank storage in the late summer and early fall months often is a major source of the river base flow.

3.7.4 LIVESTOCK GRAZING

Livestock grazing is the primary agricultural use of non-irrigated land in the Greybull Valley. The majority of land south of the Greybull River corridor in the vicinity of the alternatives is BLM land within the Bighorn River Resource Area, Grass Creek Planning Unit. The Bighorn River Resource Area is divided into grazing allotments administered by the BLM. In 1990, livestock grazed on public lands within this resource area included 24,857 sheep, 81,933 cattle, and 687 horses by 102 livestock operators (BLM 1994). A total of 157,375 AUMs were authorized on all lands within this resource area in 1990 (BLM 1994).

Lower Roach Gulch Alternative

Construction of the reservoir would occur within the Tatman Mountain Common Allotment #00639. This allotment covers 22,105 acres, and has an authorized grazing capacity of 1,687 AUMs. The carrying capacity within the construction area is approximately 22 acres/AUM. The reservoir construction area comprises approximately 4 percent of the entire allotment and approximately 2 percent of the AUMs within the allotment. There are approximately 37 AUMs of livestock forage within the proposed reservoir site (J. Sellar-Baker and C. Henrichsen, BLM, pers. commun.). In addition to forage, there is also one 1.8-acre impoundment used to provide water for livestock within the area to be inundated.

Blackstone Gulch Alternative

Construction of the reservoir in Blackstone Gulch would occur within the Fernandez/Blu-Jay Allotment #00510, and the North Blackstone Allotment #00527. The Fernandez/Blu-Jay allotment covers 10,927 acres, and has an authorized grazing capacity of 1,047 AUMs. The carrying capacity within the construction area is approximately 22 acres/AUM. The North Blackstone Allotment covers 823 acres, and has an authorized grazing capacity of 171 AUMs. The carrying capacity of the construction area is approximately 10 acres/AUM. The reservoir construction area comprises

approximately 3 percent of the Fernandez/Blu-Jay Allotment and approximately 61 percent of the North Blackstone Allotment. This area represents approximately 1 percent of the AUMs within the Fernandez/Blu-Jay Allotment and approximately 52 percent of the AUMs within the North Blackstone Allotment. There is a total of approximately 64 AUMs of livestock forage within the proposed reservoir site, 14 in the Fernandez/Blu-Jay Allotment and 50 AUMs in the North Blackstone Allotment (J. Sellar-Baker and C. Henrichsen, BLM, pers. commun.). In addition to forage, there are also two stock ponds, totaling approximately 2.2 acres, used to provide water for livestock within the area to be inundated at Blackstone Gulch.

Other livestock grazing within the boundaries of the Bighorn River Resource Area occurs on state and private land. The majority of this use is confined to winter use of irrigated farmlands. An estimated 36,900 AUMs were grazed on these lands in 1990 (BLM 1994), which represents 22 percent of all AUMs grazed in the resource area boundary.

3.8 SOCIOECONOMICS

The Greybull Valley Irrigation District covers portions of western Park and eastern Big Horn counties in northwestern Wyoming (Figure 1.1). Both the Lower Roach Gulch and Blackstone Gulch Alternatives are located south of the Greybull River near the Park and Big Horn County boundary. The project area, for purposes of describing socioeconomic conditions, is assumed to be Big Horn and Park counties.

Socioeconomic issues of importance identified during scoping deal primarily with long-term benefits and costs of supplemental irrigation water to area irrigators and the regional economy. Potential socioeconomic impacts during project construction were also a topic of concern. The description of the affected socioeconomic environment given below was developed using these issues as guidelines.

The two alternatives considered in this EIS involve project sites in close geographic proximity to each other. As a result, there is no meaningful distinction between the two sites in terms of the socioeconomic environment and descriptions that follow are not distinguished by project alternative.

3.8.1 POPULATION

Big Horn and Park counties, located at the northern end of Wyoming's Bighorn Basin, are sparsely populated even by Wyoming standards. In 1990, Park County had a population of 23,178, and Big Horn County had a population of 10,525 (USDC 1990). Together, the two counties have approximately 7.5 percent of the state's population, and contain approximately 10 percent of its land area. The largest communities in the project area are Cody and Powell in Park County, with 1990 populations of 7,897 and 5,292, respectively. Big Horn County has only three communities with populations over 1,000, Basin, Greybull, and Lovell (USDC 1990).

Population counts for the two counties and their incorporated communities are given in Table 3.7 for the period 1970 through 1990. The data show that both counties, as well as most incorporated communities in the area, experienced growth over the 20-year period from 1970 to 1990. Exceptions include the communities of Greybull, Lovell, and Manderson, in Big Horn County, and the community of Meeteetse in Park County.

Table 3.7 Population of counties and communities in the project area.

Entity	Distance to Project Sites[1]	Population[2] 1970	1980	1990	Percent Change (1970-90)
Big Horn County		10,202	11896	10525	3.2
Basin	29	1,145	1,349	1,180	3.1
Burlington	11	(no data)	158	184	16.4
Byron	43	397	633	470	18.1
Cowley	51	366	455	477	30.3
Deaver	58	112	178	199	77.7
Frannie	64	103	121	148	43.7
Greybull	35	1,953	2,277	1,789	-8.4
Lovell	48	2,371	2,447	2,131	-10.1
Manderson	41	117	174	83	-29.1
Park County		17,752	21,639	23,178	30.6
Cody	43	5,161	7,316	7,897	53.0
Meeteetse	26	459	512	368	-19.8
Powell	45	4,807	5,310	5,292	10.1

[1] As measured by highway miles

[2] USDC (1970, 1980, 1990).

The closest communities to the project sites are Burlington, Emblem, and Otto. Emblem and Otto are unincorporated communities with small populations. These three communities were established in the late 1800s, when Mormon settlers from Utah's Ashley Valley moved into the area with the intent of irrigating approximately 15,000 acres along the lower Greybull River.

In 1893, the Mormon settlers received permits from the Wyoming State Engineers Office to construct what are now known as the Farmers and Bench canals. Later in the 1890s, a number of German settlers moved into the area to acquire low-cost lands for irrigation that were available under provisions of the Cary Act. The three communities prospered until the severe droughts of the 1920s, which led to the construction of Upper Sunshine Reservoir in 1938. Lower Sunshine Reservoir was constructed in 1972 to further alleviate water shortages that have affected stability of these small rural communities (HDR 1988).

The Wyoming Department of Administration and Information (WDAI) projects that Park County's population will grow from its current level of 23,178 to approximately 26,600 by the year 2003, a 14.8 percent increase over 1990 levels. Big Horn County is expected to grow from a population of 10,525 to approximately 10,680, a 1.5 percent increase, over the same period (WDAI 1993).

3.8.2 EMPLOYMENT AND INCOME

The project area had a total labor force of 17,686 persons in 1993, of which approximately 5.1 percent were unemployed. The average weekly wage in the project area during 1993 was $366, compared to a statewide average of $418 (WDAI 1994). A breakdown of employment by industry sector is given in Figure 3.10 for the project area and the state. On a percentage basis, the distribution of employment among industries in the project area is roughly comparable to that for the state of Wyoming, with some exceptions.

One exception is that a higher percentage of workers in the project area are employed in agriculture than the rest of the state. Agricultural employment accounts for over 12 percent of employment in the project area, compared to only 6 percent for the state as a whole. The project area is under-represented relative to the state with respect to employment in mining, finance, insurance, real estate, transportation, and public utilities. The somewhat larger proportion of federal government employment in the project area is a reflection of large federal land holdings in the Bighorn Basin.

Household income in the project area is slightly below state averages. In 1989, median household income was $21,500 in Big Horn County and $25,900 in Park County. Median household income in Wyoming in 1989 was $29,100. In Big Horn County, 12.5 percent of families had incomes below the poverty level in 1989, while in Park County, only 7.3 percent fell into this category. The comparable figure for the state is 9.3 percent (WDAI 1994).

3.8.3 IRRIGATED AGRICULTURE

Big Horn and Park counties are one of the most important areas of the state in terms of irrigated agricultural production (Table 3.8). Although the project area only has 16 percent of statewide irrigated acreage for selected crops, it produces almost 57 percent of all irrigated barley in the state, almost 50 percent of the state's sugar beets and spring wheat crops, and 42 percent of the state's irrigated dry bean crops (Table 3.8). The area also produces a relatively high percentage of the state's irrigated oats and corn for silage. The area is somewhat under-represented in terms of winter wheat, alfalfa, and other hay production when compared to the rest of the state.

Of the 204,000 acres harvested in the project area in a typical year, approximately 65,000, or almost one-third of these acres, are in the Greybull Valley Irrigation District (GEI 1994a). Irrigators in the GVID also concentrate on higher valued cash crops, with the largest percentage of irrigated acreage in the district devoted to malt barley, sugar beets, dry beans, and alfalfa production (Figure 3.11). Other crops, including corn silage and oats, constitute about 6 percent of irrigated production in the district.

Figure 3.10 Employment by industry sector for the project area and the state of Wyoming (USDC 1994).

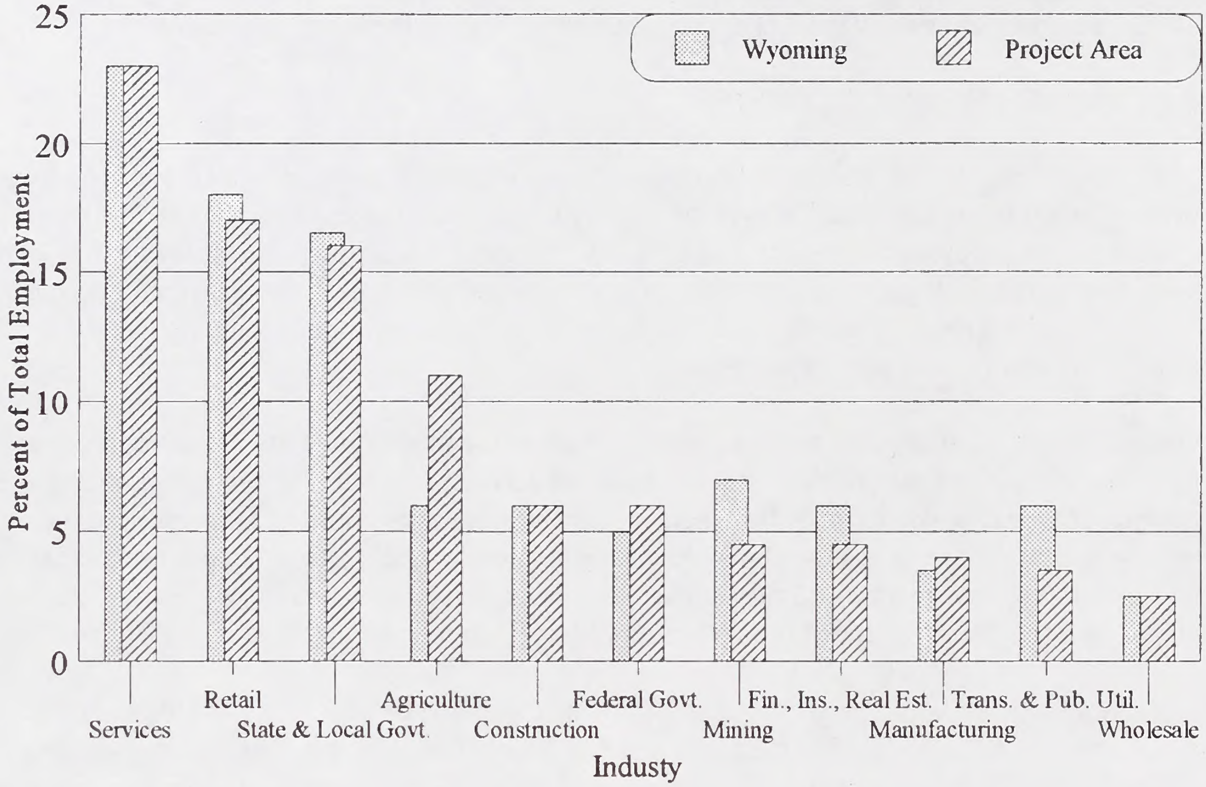
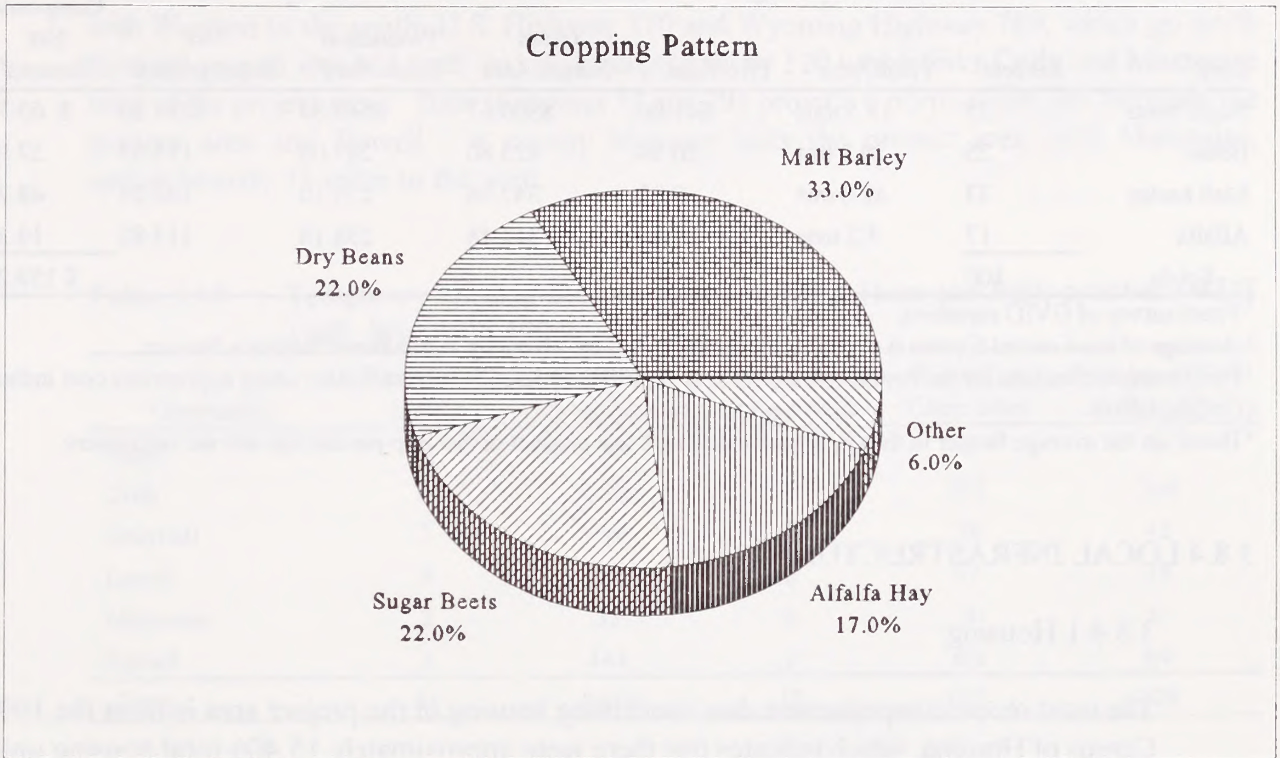


Table 3.8 Acres harvested, yields, and production of irrigated crops (five-year averages) in Wyoming and the project area (WDA 1989-1993).

	Wyoming			Project Area			
Crop	Acres Harvested	Yield/ Acre	Production	Acres Harvested	Yield/ Acre	Production	Percent of WY Production
Alfalfa hay (tons)	449,800	2.8	1,268,436	49,800	3.3	162,587	12.8
Barley (bu)	107,700	83.5	8,988,642	55,700	91.1	5,077,647	56.5
Corn for grain (bu)	47,400	102.4	4,853,760	4,500	93.6	428,630	8.8
Corn for silage (tons)	39,000	17.2	670,800	8,000	18.2	146,207	21.8
Dry beans (cwt)	39,400	17.9	706,048	17,100	17.5	299,546	42.4
Oats (bu)	16,900	67.8	1,145,820	4,600	81.7	377,581	33.0
Other hay (tons)	481,800	1.4	674,520	31,900	2.2	66,680	9.9
Spring wheat (bu)	3,800	60.2	226,427	1,600	70.5	110,004	48.6
Sugar beets (tons)	64,600	20.2	1,302,336	30,300	20.8	630,686	48.4
Winter wheat (bu)	7,300	51.5	374,774	400	54.3	21,707	5.8
Totals	1,257,700			203,900			

Figure 3.11 Percentage of irrigated acreage in the district devoted to various crop production.



Economics of irrigated farming in the GVID are described in Table 3.9. Sugar beets have the highest production cost ($545.84/acre) and highest composite net return ($63.71/acre) of any crop grown in the GVID. Beans are less expensive to produce ($287.09/acre) but, because of a lower unit value, also produce a lower net return ($27.88/acre) to the farmer. Malt barley has the lowest production cost ($215.10/acre) of crops grown in the district, but yields a net return ($48.26) higher than beans or alfalfa. Alfalfa results in much lower yields than the above crops while retaining relatively high production costs ($258.18). Alfalfa results in the lowest composite net return ($19.35/acre) of crops grown in the GVID.

Without irrigation, dryland grazing would be the only practical form of agriculture in the lower Greybull River Valley. Based on current prices for grazing land in the area, GEI (1994b) estimated net returns to grazing are approximately $6.70 per acre annually. Under the present cropping patterns, irrigation results in an average return to farmers of $36.41 per acre-foot of storage. This average return would be higher if not for periodic water shortages in the district. Because there is a greater risk associated with growing beets and dry beans in dry years, some farmers elect to plant less risky, lower value crops such as alfalfa. However, regardless of the crop, some losses are difficult to avoid under current conditions. The average cost of water shortages and crop failures to GVID members under present conditions is estimated to be approximately $1.6 million annually (GEI 1994a). This figure represents the average annual revenue loss to irrigators from yield reductions and crop failures on existing irrigated fields when compared to a full water supply scenario.

Table 3.9 Estimated returns to irrigated farming in the GVID.

Crop	Percent	Yield/Acre[1]	Price/Unit[2]	Gross Return/Acre	Production Costs/Acre[3]	Net Returns/Acre	Composite Net Returns[4]
Sugar beets	25	19.5 tons	$41.06	$800.67	$545.84	$254.83	$ 63.71
Beans	25	20.2 cwt	20.98	423.80	287.09	111.53	27.88
Malt barley	33	42.6 cwt	8.03	342.08	215.10	146.25	48.26
Alfalfa	17	4.2 tons	74.40	312.48	258.18	113.82	19.35
Totals	100						$ 159.20

[1] From survey of GVID members.
[2] Average of most recent 5 years (i.e. 1989-1993) as reported by Wyoming Agricultural Statistics Service.
[3] From enterprise budgets for the Powell area (Hewlett, et al., 1991) updated to current dollars using appropriate cost indices (USDA, 1994).
[4] Based on the average farmer in the GVID and calculated as a product of the crop percentage and net return/acre.

3.8.4 LOCAL INFRASTRUCTURE

3.8.4.1 Housing

The most recent comprehensive data concerning housing in the project area is from the 1990 Census of Housing, which indicates that there were approximately 15,400 total housing units in Park and Big Horn counties, of which approximately 575 were available for rent and approximately 300 for sale (USDC 1993b). Big Horn and Park counties have experienced population growth since the 1990 census, however, and only a relatively small amount of housing available for sale or rent 5 years ago is available today. There is virtually no rental housing available in Greybull or Basin, the Big Horn County communities that are within an easy commute of the project sites (H. Barnett, Hub Real Estate, pers. commun.).

The project area does have a number of motels and commercial campgrounds, due partially to its close proximity to Yellowstone National Park. There are 51 motels in the two-county area, with a total of 1,610 rooms (Table 3.10). The majority of the motels are located in Cody, however, which is near the eastern gateway to Yellowstone National Park and experiences heavy tourist traffic during summer. There are also 12 commercial campgrounds in the area, offering 637 campsites and 328 with full RV hookups (water, sewer, and electricity). The majority of campsites with full hookups are in Cody, however, and experience high occupancy rates during summer. Workers employed on road construction crews west of Cody during the summer of 1995 experienced difficulty finding affordable campsites for RV living accommodations (Laramie Daily Boomerang 1995).

3.8.4.2 Transportation

The project area is served by a relatively extensive system of U.S. and state highways and county roads. The primary east-west route through the project area is U.S. Highway

14/16/20, which links the community of Greybull on the Bighorn River with Cody, 53 miles to the west. Major north-south routes include U.S. Highways 16 and 20, which link Greybull with Worland to the south; U.S. Highway 310 and Wyoming Highway 789, which go north from the project area to Lovell; and Wyoming highway 120 which links Cody and Meeteetse west of the project areas. State Highways 32 and 295 provide a north-south link between the project area and Powell. A county highway links the project area with Meeteetse, approximately 33 miles to the west.

Table 3.10 Temporary housing accommodations in Big Horn and Park counties (WDT 1995, Woodall's 1994).

Community	Number of Motels	Number of Motel Rooms	Number of Campgrounds	Number of Camp Sites	Number of Full Hookup Sites
Basin	1	9	0	0	0
Cody	33	1,230	6	502	268
Greybull	7	116	2	78	42
Lovell	4	95	2	57	18
Meeteetse	2	33	0	0	0
Powell	5	141	2	n/a	n/a
Total	51	1,610	12	637	328

U.S. Highway 14/16/20 and Wyoming Highway 120 have newly paved surfaces and are built to current safety standards. State Highways 30 and 32 are narrow and without paved shoulders, although they are in generally good condition. The paved county road between the two sites is in poor condition and unsuitable for heavy traffic. A narrow bridge at the Highway 30 crossing of the Greybull River east of Otto is scheduled for replacement over the next 4 years (K. Fink, WYDOT, pers. commun.).

3.8.4.3 Law Enforcement

Local law enforcement services at the project area are provided by the Park County Sheriff's office in Cody, the Big Horn County Sheriff's office in Basin, and local police departments in Basin, Greybull, Lovell, Cody, and Powell (Table 3.11). There are over 60 law enforcement personnel in the two-county project area, with service ratios generally below one officer per 600 residents. Only rural areas of Big Horn County have a service ratio approaching one officer per 1,000 individuals. The national ratio of law enforcement personnel to population is approximately 1 to 600 (Kurian 1989).

Compared with other areas in Wyoming, the project area has relatively low crime rates (Table 3.12). In 1993, there were 52 violent crimes in the project area, or a ratio of one for each 648 individuals. The comparable ratio for the state of Wyoming during that year was 1 per 334 individuals (WDCI 1995).

Table 3.11 Service populations and law enforcement service ratios for the project area (WDCI 1995).

Community	Service Population	Number of Officers[1]	Service Ratio
Big Horn County[2]	5,425	6.0	1:904
Basin	1,180	3.5	1:337
Greybull	1,789	4.0	1:447
Lovell	2,131	7.0	1:304
Park County[2,3]	9,989	17.0	1:588
Cody	7,897	14.0	1:564
Powell	5,292	13.0	1:407

[1] Part-time officers are counted as one-half (0.5) full-time officer.
[2] The county service populations exclude communities with local police officers.
[3] Two Park County deputies provide law enforcement services for Meeteetse on a contract basis with the town.

Table 3.12 1993 crime indices for the project area and Wyoming (WDAI 1994).

Statistic	Project Area	Wyoming
Number of violent crimes	52	1,357
Violent crimes per capita ratio	1:648	1:334
Number of property crimes	979	18,467
Property crimes per capita ratio	1:34	1:25

Property crimes in the project area were also lower than elsewhere in the state in 1993, with a ratio of 1 per 34 residents. The ratio for the state in 1993 was one property crime per 25 residents (WDCI 1995).

3.8.4.4 Health Care

There are three hospitals in the project area, West Park Hospital in Cody, North Big Horn Hospital in Lovell, and Powell Hospital in Powell. The largest hospital (West Park Hospital, with 57 beds) averaged 62 percent occupancy in 1994. North Big Horn Hospital and Powell Hospital have 30 and 40 beds respectively, and much lower occupancy rates than the hospital in Cody. Both the Lovell and Powell hospitals' average occupancy was less than 20 percent during 1994 (WDAI 1994).

All three hospitals provide advanced life support (ALS) services, which consist of ambulance service plus medical technicians trained in certain emergency medication procedures. Ten ambulances and 90 trained medical technicians are available at the three hospitals, although two ambulances and their associated personnel are typically stationed in Yellowstone National Park during summer months (R. Ames, Powell Hospital, pers. commun.).

There are 38 licensed physicians in the project vicinity, five in Big Horn County and 33 in Park County (R. Labado, Powell Hospital, pers. commun.). The physician service ratio is one physician for each 890 persons, which is fewer physicians per person than national averages, but similar to other sparsely populated areas of the rural West. There is a private rural health care clinic 5 miles south of Greybull that is staffed by a physician, two physician assistants, and a nurse practitioner. A larger array of more specialized physicians is available in Billings, Montana, approximately 90 miles north of Powell and 125 miles north of Greybull.

3.8.4.5 Public Schools

Big Horn County has four school districts which run 16 public schools with a total enrollment of approximately 2,500 students. The student-teacher ratio is a relatively low 9.5, which reflects the rural nature of the county's schools. The comparable student-teacher ratio for the state as a whole is 15.1. Operating costs per student for the 1992-1993 school year were \$6,358 compared to the statewide average of \$5,302. This difference is a reflection of the relatively small classroom sizes of many of the schools in Big Horn County (WDAI 1994).

Park County has three school districts that run 16 public schools with a total enrollment of about 4,700 students. The student-teacher ratio for Park County schools is 14.0, only slightly below the statewide average of 15.1. This statistic reflects the fact that Park County schools are much larger on the average than those in Big Horn County. As a result, operating costs are lower in Park County, averaging \$4,820 per student during the 1992-1993 school year.

3.8.5 PUBLIC REVENUES

The two largest sources of revenue for local governments in Wyoming are sales and use taxes, and ad valorem (property) taxes. In fiscal year 1994, Wyoming counties, municipalities, schools, and special districts levied a total of \$436.6 million in ad valorem taxes. Of this amount, \$75.5 million went into the state school foundation fund, while the rest was spent locally. Local governments in Big Horn and Park counties levied a total of \$29.8 million in property tax assessments in 1994, or 6.8 percent of all property taxes levied statewide.

Sales and use tax collections form the second largest source of revenue to local governments. In fiscal year 1994, \$336.0 million in sales and use taxes were collected statewide. This amount was split between local government units and the state general fund according to formulas established by the legislature.

Sales and use tax collections in Park and Big Horn counties totaled \$16.3 million in fiscal year 1994. Although this figure constitutes only 4.9 percent of all sales and use taxes collected statewide, it is a significant increase over 5 years ago, when sales and use tax collections in the two-county area totaled only \$9.6 million (WDAI 1994).

Big Horn and Park counties also receive payments in lieu of taxes (PILT) on federal land holdings in the project area. The federal government owns approximately 1.5 million acres of land in Big Horn County and 3.6 million acres of land in Park County. PILT revenues to the two counties in fiscal year 1994 were $237,137 and $367,622, respectively (W. Howell, BLM, pers. commun.).

Agricultural lands in the project area are subject to property taxes based upon estimated production value. Assessed valuations range from $80 per acre for Class 2 irrigated land to $1 per acre for Class 5 grazing and waste land. Private land in the vicinity of the reservoir sites is grazing land assessed at $1 to $3 per acre (B. Meyer, Park County Deputy Assessor, pers. commun.). Property tax rates in the GVID range from 71.8 mills in rural Park County to 74.5 mills in Big Horn County near Otto (J. Payne, Big Horn County Assessor, pers. commun.).

3.8.6 LAND OWNERSHIP AND USE

Big Horn and Park counties contain a total of 9,759 square miles of land area, approximately 6.25 million acres (640 acres equals 1 square mile). 1.07 million acres are privately owned; the remainder are federal and state owned lands. Public lands in the project area include the Shoshone National Forest, Bighorn National Forest, Bighorn National Recreation Area, BLM lands, and some small state and federal land holdings.

Of the 1.07 million acres of private land in the project area, 1.02 million acres are devoted to agricultural production. Approximately 230,600 acres of that are irrigated, of which approximately 64,600 lie in the GVID. The other 793,300 acres in agricultural production are rangeland. There is no significant dryland farming in the project area. Another 50,000 acres of private land in the area are devoted to municipal areas and non-agricultural private land holdings.

Land uses on public lands in the area include grazing and a variety of recreational uses. Land at both reservoir sites is primarily rangeland used for grazing. The reservoir sites are non-classified with respect to Park County zoning ordinances, meaning that an earthen dam structure could be constructed without zoning changes. Construction of a concrete dam would require reclassification of the reservoir sites to an industrial land use category (M. Sawyer, Park County Planning Coordinator, pers. commun.).

3.9 CULTURAL AND PALEONTOLOGICAL RESOURCES

Class III cultural resource surveys of the proposed Lower Roach Gulch project area and adjacent borrow areas and the Blackstone Gulch project area were conducted by personnel from the Office of the Wyoming State Archaeologist from July 5 to July 24, 1995, October 1 to October 4 and October 23 to October 25, 1996 (Adams 1995, Eckles 1996). The survey parties walked the entire project areas with transect spacing of no more than 30 meters. Search members examined each area for the presence of paleontological as well as cultural resources.

The Willwood Formation throughout the Bighorn Basin is well known for it's fossil richness. Previous paleontological work in the basin suggests a high potential for encountering significant vertebrate and plant fossils in rocks of this formation. Fossils were first collected from the Willwood Formation in 1880 and major fossil collecting expeditions have occurred throughout the Bighorn Basin since then (Gingerich 1980). Several thousand fossil vertebrate localities producing more than 100,000 specimens are known from the Willwood Formation as a result of this work (Winterfeld 1990). Erathen-Vanir Geological Consultants conducted a paleontological investigation near the project area in 1990 (Winterfeld 1990). Results of their investigations suggest that significant fossil deposits could be located in areas of Willwood Formation rock within the project areas.

Lower Roach Gulch Alternative

During the surveys of the Lower Roach Gulch Reservoir site and adjacent borrow areas, 15 previously unrecorded prehistoric archaeological sites, six prehistoric isolated finds, and five paleontological localities were recorded (Tables 3.13 and 3.14). In addition to previously unrecorded sites, 12 sites previously recorded by Carender et al. (1991) occur in the project area. The archaeological sites consist primarily of lithic scatter including tested white quartzite cobbles and large primary flakes, and some contain scattered fire altered rock and deflated hearths. The proposed canal route is associated with Snyder's Ditch and the Old House Ditch, both of which are considered cultural sites. Of the 25 cultural sites located in the project area, Snyder's Ditch and two sites with lithic scatter and fire cracked rock are considered eligible for nomination to the National Register of Historic Places. The two prehistoric sites are considered eligible because they are associated with sediments that could yield buried artifacts if excavated; the other similar sites are not associated with such sediments. A third prehistoric site is considered unevaluated until further testing is done. The base of a projectile point was found on one of the sites. The isolated finds included one quartzite projectile point, a quartzite core, three quartzite tested cobbles, and a secondary flake.

Five paleontological localities were discovered in the Lower Roach Gulch project area during the surveys. These include bone fragments of a large mammal, possibly Coryphodon, two fossilized turtle carapaces, a disarticulated Coryphodon skeleton, and a Hyracotherium mandible (Table 3.13).

Table 3.13 Paleontological resource sites located on or near the Lower Roach Gulch Reservoir site, borrow areas, and canal route.

Locality	Description
WY-48-94-P1	Bone Fragments of Large Mammal (*Coryphodon*?)
WY-48-94-P2	Fossilized Turtle Carapace
WY-48-94-P3	Disarticulated *Coryphodon* Skeleton
WY-48-94-P4	*Hyracotherium* Mandible
WY-48-94-P5	Fossilized Turtle Carapace

Table 3.14 Summary of cultural resource sites and isolated finds located on or near the Lower Roach Gulch Reservoir site, borrow areas, and canal route.

Cultural Site	Description	Eligible (Y/N)
48PA1730	Lithic Scatter	N
48PA1731	Lithic Scatter/Fire Cracked Rock	N
48PA1732	Lithic Scatter	N
48PA1733	Lithic Scatter/Deflated Hearths	N
48PA1734	Lithic Scatter/Fire Cracked Rock	N
48PA1735	Large Cairn/Isolated Flake	N
48PA1736	Lithic Scatter/Fire Cracked Rock	N
48PA1737	Hearth/Lithic Scatter/Fire Cracked Rock	N
48PA1738	Lithic Scatter/Base of Projectile Point	unk[1]
48PA1739	Lithic Scatter/Fire Cracked Rock	N
48PA1740	Lithic Scatter	N
48PA1741	Lithic Scatter/Fire Cracked Rock	N
48PA1742	Lithic Scatter	N
48PA1172	Lithic Scatter/Fire Cracked Rock	N
48PA1176	Lithic Scatter/Fire Cracked Rock/Sheepherder Camp	N
48PA1181	Lithic Scatter/Fire Cracked Rock	N
48PA1165	Snyder's Ditch	Y
48PA1166	Old House Ditch	N
48PA1167	Lithic Scatter/Fire Cracked Rock	N
48PA1168	Lithic Scatter/Fire Cracked Rock	N
48PA1169	Lithic Scatter	N
48PA1170	Lithic Scatter/Fire Cracked Rock	N
48PA1173	Lithic Scatter/Hearth/Fire Cracked Rock	Y
48PA1183	Lithic Scatter/Fire Cracked Rock	N
48PA1184	Lithic Scatter/Fire cracked Rock	Y
48PA1814	Lithic Scatter/Fire Cracked Rock	N
48PA1815	Lithic Scatter/Fire Cracked Rock	N
Isolated Find	**Description**	**Eligible (Y/N)**
WY-48-94-IF-1	Quartzite Projectile Point	NA
WY-48-94-IF-2	Quartzite Core	NA
WY-48-94-IF-3	Quartzite Tested Cobble	NA
WY-48-94-IF-4	Quartzite Tested Cobble	NA
WY-48-94-IF-5	Quartzite Tested Cobble	NA
WY-55-96-IF-1	Secondary Flake	NA

[1] unknown eligibility; considered eligible pending further testing

Blackstone Gulch Alternative

During the surveys of the Blackstone Gulch project area, seven previously unrecorded prehistoric archaeological sites and three prehistoric isolated finds were recorded (Table 3.15). No paleontological sites were recorded at this location, however, previous paleontological investigations

in the area suggest significant fossil deposits could be located in areas of Willwood Formation rock within the project area (Winterfeld 1990). The archaeological sites consist primarily of lithic scatter including tested white quartzite cobbles and large primary flakes. Some contain scattered fire altered rock and deflated hearths. One tool fragment was found associated with one site. None of the cultural sites located in the Blackstone Gulch project area are considered eligible for nomination to the National Register of Historic Places. The two isolated finds located include one late archaic projectile point and a projectile point midsection.

Table 3.15 Summary of cultural resource sites and isolated finds located on or near the Blackstone Gulch Reservoir site and canal route.

Cultural Site	Description	Eligible (Y/N)
48PA1743	Fire Cracked Rock	N
48PA1744	Deflated Hearth/Fire Cracked Rock	N
48PA1745	Lithic Scatter	N
48PA1746	Lithic Scatter/Fire Cracked Rock/Tool Fragment	N
48PA1747	Lithic Scatter/Fire Cracked Rock	N
48PA1748	Lithic Scatter/Fire Cracked Rock	N
48PA1816	Lithic Scatter	N
Isolated Find	**Description**	**Eligible (Y/N)**
WY-48-94-IF-6	Late Archaic Projectile Point	NA
WY-48-94-IF-7	Projectile Point Midsection	NA

3.10 RECREATIONAL RESOURCES

3.10.1 FISHING

Wyoming has the highest per capita rate of fishing participation in the U.S. (over 50 percent), and fishing is an important recreational activity in Wyoming's Bighorn Basin. There are approximately 2,300 miles of streams in the basin, of which approximately 1,800 miles are classified as Class 1 (fisheries of national importance), Class 2 (fisheries of state importance), or Class 3 (fisheries of regional importance) streams by the WGFD (WGFD 1987). The basin also contains approximately 22,200 acres of natural lakes, reservoirs, and farm ponds which are productive fisheries.

In 1985, the basin experienced approximately 377,000 fishing recreation days, with total expenditures associated with fishing activity of approximately $13.6 million. Fishing activity is expected to almost double by the year 2040, with expenditures growing to approximately $25.1 million by that date (HDR 1988; Table 3.16).

The Greybull River is the third largest of the major tributaries to the Bighorn River in Wyoming. It flows for over 93 miles from the Absaroka Range eastward to its confluence with the Bighorn, and drains over 1,150 square miles. It is home to Yellowstone and Snake River cutthroat trout, mountain

whitefish, and several native and non-native nongame fish (Annear and Braaten 1995). The Greybull River has been highly developed for irrigation over the past century, and flow patterns throughout the lower 70 miles of the river are largely dependent upon irrigation withdrawals and return flows. As a result, fish habitat along this section of the river is degraded, and lack of public access further limits the value of the lower river as a recreational resource (Zafft and Annear 1992).

Table 3.16 Projected fishing recreation days and related revenue for the Bighorn Basin, 1985 to 2040 (HDR 1988).

Year	Recreation Days			Total Expenditures
	Resident	Nonresident	Total	
1985	306,400	70,600	377,000	$13,587,000
1990	314,100	73,800	387,900	13,980,000
2000	358,000	79,200	437,200	15,757,000
2010	405,600	83,400	489,000	17,624,000
2020	466,100	87,200	553,300	19,941,000
2030	530,000	89,800	619,800	22,338,000
2040	604,100	91,000	695,100	25,051,000

The lower 33 miles of the Greybull River, from the Farmers Canal to the Bighorn River, are particularly degraded. This portion of the river is characterized by numerous irrigation withdrawals and extreme daily fluctuations and discharge. High turbidity and stream temperatures severely limit the production of trout in this section of the lower river.

The most popular fishery in the Greybull River Valley is Upper Sunshine Reservoir. The WGFD manages Upper Sunshine as a basic yield fishery for Snake River and Yellowstone cutthroat trout. Splake are common and brown trout are reported to be rare in the reservoir. The trout population does not reproduce in the reservoir; therefore, about 25,000 fingerling cutthroat trout are stocked annually. Splake are occasionally stocked to increase species diversity and for biological control of nongame fish species (WGFD 1996). In addition to trout, longnose sucker, white sucker, mountain sucker, mountain whitefish, lake chub, and longnose dace also occur in the reservoir (Johnson 1982, WGFD 1996). WGFD (1996) indicates that the present trout fishery is limited by fluctuating water levels and expansion of nongame fish species and mountain whitefish. The WGFD anticipates that these factors may limit the growth and survival of Upper Sunshine Reservoir trout.

Upper Sunshine Reservoir receives an estimated 3,000 to 4,000 angling days of use each year (S. Yekel, WGFD, pers. commun.). It is also used for boating, waterskiing, and jet skiing. A lack of camping facilities at the reservoir is a limiting factor in current usage rates (T. Annear, WGFD, pers. commun.). In low water years the reservoir is occasionally drained below the minimum pool needed to support fish over the winter, and thus must be restocked on a periodic basis. Fluctuating reservoir levels also negatively affect quality of the fishery and ease of access by anglers.

3.10.2 HUNTING

The Greybull River Valley provides habitat for deer, antelope, small game, upland game birds, and waterfowl. No estimates are available of hunting activity or expenditures in the Greybull River Valley itself, although estimates are available for the hunt areas that include the Greybull River Valley.

The project area is in pronghorn hunt area 77 which is approximately 1,184 square miles in size. Antelope harvest in this area during the period 1990-1993 averaged 121, and the number of hunter recreation days spent pursuing pronghorn in the area averaged 251 over this same period (Table 3.17; WGFD 1994). The Greybull River Valley is within deer hunt areas 124 and 165. Together these areas comprise approximately 834 square miles. Harvest in these two areas combined from 1990 to 1993 averaged 896 mule deer and 617 white-tailed deer. Mean recreation days expended per year averaged 4,054 days for mule deer and 1,997 days for white-tailed deer (Table 3.17; WGFD 1994).

Table 3.17 Summary of big game harvest and hunter recreation days for pronghorn hunt area 77 and deer hunt areas 124 and 165 in the Greybull River Valley, Wyoming, 1990-1993.

Species	Year	Harvest	Hunter-Days
Pronghorn	1993	117	246
	1992	276	578
	1991	49	95
	1990	43	85
Mule Deer	1993	680	4297
	1992	1058	4002
	1991	991	4124
	1990	854	3792
White-tailed Deer	1993	228	2493
	1992	186	2074
	1991	157	1968
	1990	46	1454

The primary species of waterfowl and upland game hunted in the project area are Canada geese, ducks, ring-necked pheasant, chukar, gray partridge, sage grouse, mourning dove, and cottontail. The Greybull Valley is within upland game management area 16, which encompasses approximately 1,868 square miles, and waterfowl management area 4C, which encompasses approximately 11,143 square miles. A summary of harvest and hunter-days spent pursuing waterfowl and upland game from 1991 to 1994 is presented in Table 3.18 (WGFD 1995c). Average annual harvest of waterfowl in this area is 1,422 geese and 7,141 ducks. Hunter-days in pursuit of waterfowl averaged 8,648 from 1991 to 1994. Average annual harvest of upland game in the area from 1991 to 1994 was 812 ring-necked pheasants, 517 chukars, 89 gray partridge, 365 sage grouse, 775 mourning doves, and 1,504 cottontail rabbits. During this same period, average number of hunter-days spent pursuing these species was 1,125 for ring-necked pheasant, 538 for chukar, 171 for gray partridge, 379 for sage grouse, 225 for mourning dove, and 1,599 for cottontail rabbit (WGFD 1995c).

Table 3.18 Summary of waterfowl and upland small game harvest and hunter recreation days for upland game management area 16 and waterfowl management area 4A, 1991-1994.

Species	Year	Harvest	Hunter-Days
Canada Goose	1994	1463	3071
	1993	1162	2698
	1992	1186	3290
	1991	1878	3107
Ducks	1994	8806	6066
	1993	6199	5124
	1992	7371	5902
	1991	6189	5332
Ring-necked Pheasant	1994	563	1077
	1993	482	693
	1992	1378	1376
	1991	825	1355
Chukar	1994	120	319
	1993	340	342
	1992	1048	825
	1991	558	665
Gray Partridge	1994	17	16
	1993	23	129
	1992	257	407
	1991	60	130
Sage Grouse	1994	287	322
	1993	247	322
	1992	416	417
	1991	508	454
Mourning Dove	1994	506	179
	1993	105	36
	1992	1072	301
	1991	1418	384
Cottontail Rabbit	1994	336	545
	1993	689	669
	1992	1606	4217
	1991	3386	963

3.10.3 NONCONSUMPTIVE RECREATION

According to the 1985 State Comprehensive Outdoor Recreation Plan (SCORP), the most important nonconsumptive outdoor recreational activities in the Bighorn Basin are bicycling, sightseeing, camping, horseback riding, and picnicking, in that order (University of Wyoming and Wyoming

Recreation Commission 1985). The recreational activity data in the SCORP are for all of Big Horn, Hot Springs, Park, and Washakie counties, however, which include many mountainous areas that are not representative of the recreational opportunities available in the lower Greybull Valley where the reservoir alternatives would be located.

The BLM has published nonconsumptive recreational use statistics for the Grass Creek planning area, which includes that part of the basin which lies generally south of the Greybull River, west of the Bighorn River, and north of Owl Creek (BLM 1995). Although this planning area does not correspond to the study area for this EIS, the recreational opportunities available in the Grass Creek planning area should be more representative of those in the lower Greybull River Valley than those presented in the SCORP.

Table 3.19 shows estimated nonconsumptive recreational activity in the Grass Creek planning area as of 1990. At that time, the most popular activities were picnicking, hiking, camping, 4-wheel driving, and sightseeing. Boating and snowmobiling were relatively unimportant pursuits, largely due to a lack of opportunities. There are few reservoirs of significant size in the planning area and snowfall is often insufficient for recreational snowmobiling. It should be noted that Upper and Lower Sunshine reservoirs are just outside the boundary of the planning area, otherwise, water-based recreational activity would be higher.

Table 3.19 Estimated nonconsumptive recreational activity in the Grass Creek Planning Area, 1990.

	Activity Days		
Activity	Resident	Nonresident	Total
Picnicking	3,825	3,000	6,825
Hiking	3,575	625	4,200
Camping	2,250	1,500	3,750
Four-wheel driving	3,450	200	3,650
Sightseeing	1,125	1,575	2,700
Boating/canoeing	425	425	850
Snowmobiling	400	25	425
Other[1]	9,000	3,500	12,500
Totals	24,050	10,850	34,900

[1] includes bicycling, archery, shooting, sledding, skating, horse riding, cross country skiing, outdoor swimming, and water skiing.

3.11 VISUAL/AESTHETICS

The Greybull River corridor and its irrigated farmland offers a distinct change in visual appearance from the surrounding badlands. The lower Greybull drainage area is primarily rolling to flat farm

fields bisected by the lush cottonwood riparian corridor of the Greybull River and surrounded by shortgrass-shrubland foothills with rocky badland areas (Appendix C). The upper Greybull drainage area is rolling shortgrass foothills at the base of high, rugged mountains. These contrasting environments add a strong visual appeal to the project areas. Appendix C shows pictures of each alternative site showing the existing visual appeal of the project areas.

Under the BLM Visual Resource Management classification, both alternatives occur in a mixture of VRM classes III and IV (BLM 1994). Class IV areas within the project areas are primarily the agricultural lands along the Greybull River corridor. Class III areas are those adjacent to the agriculture corridor; primarily the areas of the reservoir sites for each alternative. Under the BLM VRM plan, the objective for class III areas is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape. The objective for class IV areas is to provide for management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements.

3.12 HAZARDOUS MATERIAL

According to officials with WDEQ, there is no record of hazardous material or waste ever being stored or spilled in either the Lower Roach Gulch or Blackstone Gulch Alternative project areas (M. Hackett, WDEQ-WQD, pers. commun.). No above or below ground fuel tanks are registered with WDEQ in either project area (M. Hackett, WDEQ, pers. commun.). Visual and olfactory inspections of the two alternatives during site visits revealed no stained soil, disturbed ground, debris, or odors which might indicate the presence of hazardous material or waste. No sites such as ranch dumps, accumulated refuse, or abandoned homesteads were located during site visits.

CHAPTER 4.0 ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

The previous chapter described the physical, biological, social, and economic characteristics of the environment that may be affected by implementation of the proposed action or the alternatives. This chapter examines how each of these characteristics may be affected (beneficially or adversely) by implementation of each of the alternatives, including the No Action Alternative. A summary of effects by issues and alternative is provided in Table 4.1.

Direct, indirect, and cumulative effects are described in this chapter. This process has not identified any proposed action(s) that may be anticipated to occur in the reasonably foreseeable future within the project area or within the geographic scope of the EIS's resource effects analysis. While day to day human activities in the study area may result in future environmental effects to resources evaluated in this EIS, any attempt to quantify such effects would be speculative and unreliable. Therefore, the cumulative effects analysis primarily includes past actions, current actions, and the proposed action and its alternative.

4.2 LAND FEATURES

4.2.1 GEOLOGY AND SOILS

Lower Roach Gulch Alternative

There are unique geologic characteristics at the Lower Roach Gulch dam site that are addressed through incorporation of certain elements into dam design and construction. To account for the shear zone located 30 to 40 feet beneath the surface of the proposed dam site, the applicant's consultants recommend use of conservatively high seismic coefficients in final dam design. Preliminary dam design includes slope berming to help protect against slope failures and a cutoff trench beneath the dam to a depth of 40 feet and into the shear zone. Dam construction would be paced to reduce the potential for slope failures during construction.

The Willwood Formation, into which the dam abutments would be constructed, consists of layers of siltstone, sandstone, and claystone forming a "badlands" topography. Erosional sinks and cavities are found in areas where dispersive claystone bedrock is exposed. There is the potential for movement of soil particles by percolation of water leading to the development of channels (piping) through the Willwood Formation due to pervious stratigraphic layers when the formation is subjected to hydraulic head created by filling of the proposed reservoir. There is a potential for piping through the abutments and foundation of the dam. In order to prevent dam failure due to piping, the preliminary dam design includes the cutoff trench described above; a double lined grout curtain beneath the cutoff trench; chimney and blanket drains in the dam to control seepage; and an impervious dam core.

Table 4.1 Summary of environmental effects analysis by issue and alternative.

Impact by Resources	Alternative: Lower Roach Gulch	Alternative: Blackstone Gulch	Alternative: No Action
LAND FEATURES			
GEOLOGY AND SOILS			
Erosion of siltstones and claystones of Willwood Formation at reservoir site	Erosion will reduce effective life of project; 2,500 acre-feet sediment storage pool in reservoir design; reduction of 28.6 acre-feet/year sediment loading in GR	Erosion will reduce effective life of project; 2,500 acre-feet sediment storage pool in reservoir design; reduction of 20-25 acre-feet/year sediment loading in GR Erosion of dispersive clays and highly saline material removed during construction of the diversion tunnel may cause significant impacts to water quality and plant communities.	No concerns over erosion; no reduction in sediment loading in GR
MINERAL RESOURCES			
Loss of mineral resources at reservoir site	NSO stipulation attached to land; no significant loss to extractable coal	NSO stipulation attached to land; no significant loss to extractable coal	No impacts to mineral resources
WATER RESOURCES			
SURFACE HYDROLOGY			
Reregulation of GR flows	Net result of leveling of flows in lower GR; significant benefits of irrigation water conservation	Similar impacts as LRG Alternative	No flow reregulation or irrigation water conservation
Timing of irrigation water delivery	Time between order for water and delivery reduced; recapture of water released from Sunshine reservoirs possible if not needed	Similar impacts as LRG Alternative	No reduction in time of water delivery
GR system depletions	Depletion of flow at mouth of GR by ≈5,480 acre-feet/yr; increase flow at mouth of Dry Creek by ≈2,120 acre-feet/year	Similar impacts as LRG Alternative	No new depletions at mouth of GR; no increase flow at mouth of Dry Creek

Impact by Resources	Alternative: Lower Roach Gulch	Alternative: Blackstone Gulch	Alternative: No Action
Evaporation losses	Evaporation loss increase of ≈1,700 acre-feet/yr	Slightly greater losses than LRG Alternative due to configuration of reservoir and length to delivery	No new evaporation losses
Dam failure	Substantial flooding in Greybull 6 hours after dam break	Similar impacts as LRG Alternative; slightly longer time for water to reach Greybull	No new potential for a dam break
Flooding above diversion dam	No increased potential for flood damage above diversion dam	No increased potential for flood damage above diversion dam	No increased potential for flood damage
Hydropower development	No potential for hydropower development	No potential for hydropower development	No potential for hydropower development
WATER QUALITY			
Total dissolved solids	TDS in reservoir will range between 400-700 mg/L; no significant change expected to TDS in GR	Similar impacts as LRG Alternative	No changes in TDS
Sediment loading	Variable effects to GR sediment loading; diversion dam and reservoir will act as sediment traps thus generally reducing sediment load in GR downstream of diversion dam	Similar impacts as LRG Alternative	No changes in sediment loading
Turbidity	Variable effects to GR turbidity; turbidity in reservoir water potentially higher than GR water	Similar impacts as LRG Alternative	No changes to turbidity
Other water quality concerns	No significant increase in conventional pollutants expected; no significant impact to groundwater quality expected	Similar impacts as LRG Alternative	No changes to other water quality concerns
GROUNDWATER HYDROLOGY			
Groundwater availability	Increased groundwater levels expected due to increased recharge from increased irrigation	Similar impacts as LRG Alternative	No changes to groundwater availability

Impact by Resources	Alternative: Lower Roach Gulch	Alternative: Blackstone Gulch	Alternative: No Action
WATER RIGHTS			
Water right priority	Reservoir will have later priority water right than existing rights; increased supplies to shareholders in valley; return flows from increased irrigation available to other rights	Similar impacts as LRG Alternative	No impacts to water rights
AIR QUALITY			
Impacts from construction	Temporary increase in fugitive dust, TSP and exhaust emissions during construction	Similar impacts as LRG Alternative	No air quality impacts from construction
Long term impacts	Increased dust, TSP, and exhaust emissions from increased agriculture activity in Basin	Similar impacts as LRG Alternative	No long term impacts
NOISE			
Increased noise from construction	Potential impacts to nesting raptors; no other significant impacts expected	Similar impacts as LRG Alternative	No impacts from noise
Increased noise from increased agriculture activity in Basin	No significant impacts expected	No significant impacts expected	No impacts from noise
BIOLOGICAL RESOURCES			
WETLANDS			
Impacts at diversion dam and along canal route	≈0.88 acres impacted; new wetlands formed at canal terminus	No wetlands impacted	No wetlands impacted
Impacts at reservoir site	≈2.16 acres impacted; new wetlands formed around shoreline	≈0.55 acres impacted; new wetlands formed around shoreline	No wetlands impacted
Impacts along return flow route	≈0.57 acres impacted	≈0.02 acres impacted	No wetlands impacted
Impacts along GR	≈1.15 acres impacted; ≈6.2 river-miles between diversion and return flow	≈1.46 acres impacted; ≈3.9 river-miles between diversion and return flow	No wetlands impacted

Impact by Resources	Alternative		
	Lower Roach Gulch	Blackstone Gulch	No Action
Other wetland impacts	Net increase in wetlands in valley due to increased irrigation (e.g. seeps along canals, inefficient irrigation practices); potential increase in wetlands along Dry Creek due to increased return flow	Similar impacts as LRG Alternative	No wetlands impacted
VEGETATION			
Impact to plant communities	Loss of ≈551 acres of mixed grassland-sagebrush shrubland, 19 acres mixed riparian shrub-shrub steppe, 105 acres rocky outcrops; impacts to ≈1,025 acres mixed grassland-sagebrush shrubland; ≈1,400 acres of currently idle land irrigated	Loss of ≈680 acres of mixed grassland-sagebrush shrubland, ≈16 acres mixed riparian shrub-shrub steppe, ≈34 acres rocky outcrops; impacts to additional acres mixed grassland-sagebrush shrubland (similar to LRG); ≈1,400 acres of currently idle land irrigated	No impacts to plant communities
WILDLIFE			
Impacts to mammals	Probable change in mammal community on site; slightly reduced carrying capacity	Similar impacts as LRG Alternative	No impacts to mammals
Impacts to birds	Probable change in bird community on site; slightly reduced upland carrying capacity; increase in waterbird carrying capacity	Similar impacts as LRG Alternative	No impacts to birds
Impacts to reptiles & amphibians	Probable change in reptile & amphibian community on site; slightly reduced carrying capacity	Similar impacts as LRG Alternative	No impacts to reptiles & amphibians
AQUATIC RESOURCES			
Impacts to fish	Diversion structure would block fish passage in GR during low flow periods; altered flows would slightly degrade aquatic habitat	Similar impacts as LRG Alternative	No impacts to fish

Impact by Resources	Alternative: Lower Roach Gulch	Alternative: Blackstone Gulch	Alternative: No Action
Impacts to invertebrate Community	No impacts anticipated	No impacts anticipated	No impacts to invertebrates
SPECIES OF SPECIAL INTEREST			
Impacts to raptors	Potential disturbance to nesting raptors from construction activity; insignificant loss of habitat to raptors	Similar impacts as LRG Alternative	No impacts to raptors
Impacts to waterfowl and waterfowl habitat	Net increase in waterfowl habitat and waterfowl use in Basin	Similar impacts as LRG Alternative	No impacts to waterfowl
Impacts to big game crucial range or migration routes	No impacts to crucial range or migration routes	Similar impacts as LRG Alternative	No impacts to big game
Impacts to upland game birds	No impacts to sage grouse leks; insignificant loss of ≈675 acres of sage grouse brood rearing and winter habitat	No impacts to sage grouse leks; insignificant loss of ≈730 acres of sage grouse nesting, brood rearing, and winter habitat	No impacts to upland game birds
THREATENED, ENDANGERED, & CANDIDATE SPECIES			
Impacts to T&E species	Net increase in foraging habitat for migrant and winter resident bald eagles and peregrine falcons	Similar impacts as LRG Alternative	No impacts to T&E species
Impacts to candidate species	No significant impacts anticipated	No significant impacts anticipated	No impacts to candidate species
Impacts to Wyoming species of concern	No significant impacts anticipated	No significant impacts anticipated	No impacts to Wyoming species of concern
LAND USE			
CROPS & CROPPING PATTERN			
Changes in crops	≈ 2.5% increase in dry beans, 2.5% increase in sugar beets, 3.3% decrease in malt barley, 1.7% decrease in alfalfa grown in valley	Similar impacts as LRG Alternative	No change in cropping patterns
Changes in acreage in valley	≈ 1,400 additional acres of crop land will be irrigated	Similar impacts as LRG Alternative	No additional acres irrigated

Impact by Resources	Alternative: Lower Roach Gulch	Alternative: Blackstone Gulch	Alternative: No Action
Reduction in irrigation shortages	Irrigation shortages reduced to approximately 3,600 acre-feet/yr	Similar impacts as LRG Alternative	No reduction in irrigation shortages
LIVESTOCK GRAZING			
Lost AUMs at reservoir site	Loss of 2.1% of Tatman Mountain Common Allotment AUMs	Loss of 1.3% of Fernandez/Blu-Jay Allotment AUM's and 52.6% of North Blackstone Allotment AUM's	No loss of livestock AUM's
SOCIOECONOMICS			
POPULATION & EMPLOYMENT			
Temporary construction work force	≈135 workers employed first year and 190 employed second year	≈147 workers employed first year and 207 employed second year	No temporary work force
Population increase	≈260 people in first year and 317 people in second year	≈286 people in first year and 348 people in second year	No population increase
INCOME			
Increase in household income	≈$6.7 million increase in local household income over 2 year period	≈$7.3 million increase in local household income over 2 year period	No increase in household income
Long term effects from increased agriculture	≈$856,000 increase in farm income in Basin	Similar increase as LRG Alternative	No increase in farm income
IRRIGATED AGRICULTURE			
Reduction of total crop failure	Reduction or elimination of years with widespread crop failures due to drought	Similar impacts as LRG Alternative	No change in crop failure rate
Increase current crop yields	Irrigation water provided by alternative will allow efficient and timely application of irrigation water to maximize crop yields	Similar impacts as LRG Alternative	No change in current irrigation system
Increased cost of irrigation	≈$19/share cost for 1 acre-foot of irrigation water from LRG	≈$21/share cost for 1 acre-foot of irrigation water from BG	No increase in cost of irrigation water

Impact by Resources	Alternative: Lower Roach Gulch	Alternative: Blackstone Gulch	Alternative: No Action
LOCAL INFRASTRUCTURE			
Impacts to housing	Temporary housing needed for ≈81 households during first year and 114 household during the second year	Temporary housing needed for ≈90 households during first year and 125 household during the second year	No increased demands for housing
Increased traffic in area	No significant impacts to roads or traffic safety anticipated	No significant impacts to roads or traffic safety anticipated	No change in traffic
Increased demands for law enforcement	One deputy in Big Horn County needed	Similar impacts as LRG Alternative	No increased need for law enforcement
Increased need for emergency medical services	Increased demand for emergency medical services for accidents associated with construction	Similar impacts as LRG Alternative	No increased need for emergency medical services
PUBLIC REVENUES			
Increase in sales and use taxes	≈$212,000/yr generated in sales and use tax for Park County and $265,000/yr for Big Horn County during construction; ≈$16,000/yr increase in sales and use tax over long term; loss of ≈$241/yr property taxes to Park County	≈$233,000/yr generated in sales and use tax for Park County and $291,500/yr for Big Horn County during construction; ≈$16,000/yr increase in sales and use tax over long term; loss of ≈$180/yr property taxes to Park County	No increase in sales and use tax
LANDOWNERSHIP AND USE			
Loss of private land to project	≈355 acres of private land would be purchased by GVID	≈50 acres of private land would be purchased by GVID	No loss of private land
CULTURAL & PALEONTOLOGICAL RESOURCES			
Impacts to cultural sites	Potential impacts dependant on results of evaluative testing at two sites potentially eligible for nomination to the National Register of Historical Sites; potential impacts to one site of unknown eligibility	No sites eligible for nomination to the National Register of Historical Sites; no impacts anticipated	No impacts to cultural resources

Impact by Resources	Alternative: Lower Roach Gulch	Alternative: Blackstone Gulch	No Action
Impacts to paleontological resources	Fossils in Willwood Formation will be impacted.	Fossils in Willwood Formation will be impacted	No impacts to paleontological resources
RECREATIONAL RESOURCES			
FISHING			
Impacts to area fishery	Potential positive impact to Upper Sunshine Reservoir fishery due decreased invasion of 5,000 acre-feet minimum pool	Similar impacts as LRG Alternative	No impacts to area fishery
HUNTING			
Impacts to hunting	Potential increase in hunting opportunities due to improved access to public lands around reservoir site	Similar impacts as LRG Alternative	No impacts to hunting
NONCONSUMPTIVE RECREATION			
Impacts from increased human use	Potential increase in human use related impacts on public lands; potential increase in trespass related impacts on private land near site	Similar impacts as LRG Alternative	No new impacts
VISUAL/AESTHETICS			
Impacts to visual environment	No change in VRM classification of site; no significant impacts	Similar impacts as LRG Alternative	No impacts to visual environment

Due to the "badlands" topography of the reservoir basin resulting from erosion of the siltstones and claystones of the Willwood Formation, there is a potential for significant sediment accumulation in the reservoir. Estimates of annual sediment yield to the proposed reservoir were prepared by SWWRC as part of the diversion dam redesign in June of 1996 (SWWRC 1996b). Sediment yield from several sources was examined including the Greybull River through diversions from the river, gulches along the delivery canal alignment that would contribute sediment through intercepted flows, and the unnamed gulch (reservoir site) drainage area. Sediment inflows from the Greybull River were estimated by preparing a sediment rating curve for the Greybull River at Meeteetse and a flow duration curve for flows in the canal and using the curves to estimate suspended sediment load delivered to the reservoir through the canal. Estimated sediment delivery ranged from 12.34 acre-feet per year with a 500 cfs required bypass at the diversion dam to 18.15 acre-feet per year with an 800 cfs bypass. Using the required bypass of 570 cfs obtained from WEST Team modeling, the annual sediment delivery from the Greybull River is estimated to be 13.70 acre-feet per year.

States West Water Resources Corporation estimated sediment yield from the gulches along the canal alignment based on recent research conducted in the Fifteenmile Creek drainage basin located immediately south of the Greybull River Valley by the University of Wyoming and BLM. Data from the Fifteenmile Creek basin should be applicable to the gulches on the south side of the Greybull River because the drainages are located in the same geologic formation. An average suspended sediment yield of 0.3 acre-foot per square mile per year was used to estimate sediment inflow to the canal from the gulches. It was assumed that the interceptor structures along the canal alignment would bypass any bedload and only divert the suspended sediment load into the canal. At this rate, sediment inflow from the intercepted gulches would average 7.69 acre-feet per year.

Sediment yield from the reservoir basin was estimated to be approximately 0.6 acre-foot per square mile per year. The estimated yield was estimated by assuming that the estimated bedload, which was not measured in the research, would be approximately equal to the suspended load. Annual sediment yield from the reservoir site was estimated to be approximately 7.2 acre-feet. Sediment accumulation in the reservoir due to wave action on the sides of the reservoir basin was not estimated, but should be relatively minor due to the sheltered location of the reservoir. Total sediment yield to the proposed reservoir from all sources would be approximately 28.6 acre-feet per year.

The preliminary reservoir design prepared by GEI (1994a) provides 834 acre-feet of dead storage below the outlet works for sediment storage. This sediment storage pool could be increased to approximately 2,500 acre-feet by adding stop-logs when necessary to the outlet structure. Under the projected sediment yield scenario, sediment accumulations would begin to encroach on designed storage capacity (2,500 acre-feet) after approximately 87 years with the use of stop-logs. Under the proposed reservoir operation scenario, there are no plans to flush sediment from the storage pool. The spillway and outlet works were designed to be easily modified (raised) to add sediment storage when it becomes necessary to maintain the operational capacity of the reservoir. The indirect effect of sediment accumulation in the reservoir is a potential reduction in sediment loading of the Greybull River by approximately 28.6 acre-feet of sediment annually.

Impacts to reservoir storage could be assessed by periodic resurveys of the reservoir basin and by observation of sediment accumulation near the reservoir outlet works. Since the reservoir would be either totally or nearly drained each year, observation of sediment accumulation would be easily accomplished. Impacts to sediment loading in the Greybull River would be more difficult to assess due to the limited amount of preproject data available and because effects of the project are expected to be minor. Periodic monitoring of sediment discharge at the Greybull River near Basin station may indicate if the project has a significant positive or negative impact on sediment discharge.

Blackstone Gulch Alternative

The Blackstone Gulch Alternative is similar to the Lower Roach Gulch Alternative in respect to addressing site geologic and soil characteristics. However, since no geotechnical drilling has been done at the Blackstone site, very little information is available on subsurface conditions. Investigations of surficial geology made by GEI did not find any indications of faults in the dam area (M. O'Grady, SWWRC, pers. commun,). If shear zones or faults exist at the Blackstone dam site, it is possible that similar measures to those taken in the preliminary design of the Lower Roach Gulch dam could be implemented to allow safe construction and operation of the Blackstone Gulch Reservoir. Similar measures as incorporated for Lower Roach Gulch could also be incorporated to address potential "piping" at the dam site.

The diversion canal that would deliver water from the Greybull River to the Blackstone Gulch Reservoir includes an approximately 1-mile-long tunnel through the Willwood Formation (GEI 1994b). The proposed concrete lined tunnel would be 13 feet in diameter and would deliver diverted water to the reservoir at the normal high-water line. The upstream and downstream termini of the tunnel would include concrete wingwall and headwall structures and riprap to minimize erosion as flows enter and exit the tunnel (see Figure 2.4). The downstream end of the tunnel would include a stilling basin to reduce erosion of the sides of the reservoir. Guardrails would be installed along the wingwall and headwall sections to allow safe crossing of the tunnel ends. It is assumed that construction and long-term maintenance of a mile-long tunnel through this formation is feasible. Preliminary cost estimates prepared by GEI (1994b) are predicated on the assumption that tunneling would be difficult. An extensive geotechnical drilling program would be necessary to determine appropriate tunnel design engineering and construction practices for tunnel installation in the interlayered sandstone, siltstone, and claystone of the Willwood Formation.

Maximum depth of the invert of the tunnel would be approximately 200 feet. To construct a 13-foot tunnel, a rough bore approximately 17 feet in diameter would be required to allow for grouting, anchoring, and irregularities in the sedimentary section. Approximately 44,000 cubic yards of waste material would be removed from the tunnel during construction. Some of this material could be used for general fill for construction of the canal and dam or disposed of in the reservoir basin below the high-water line. Placement of the waste material in the reservoir basin would not significantly affect storage capacity because it would displace only about 27 acre-feet of potential storage. It is likely that a substantial portion of the material would consist of dispersive clays or highly saline material that would not be suitable for these uses. Disposal of this unsuitable material should not be a

significant problem because there is sufficient room in the upper portion of the reservoir basin, above the high-water line of the reservoir and near the tunnel outlet, to construct a designed fill against the exposed slopes of the Willwood Formation. Materials removed from the tunnel would be similar in quality to those against which they would be placed and would remain above the high-water line of the reservoir so that leaching would not be a problem. Sufficient room exists to construct a nonerosive drainage system to prevent runoff from the waste material from carrying sediment and salts into the reservoir and the disposal area is near enough to the tunnel outlet so that the expense of moving the material to the disposal area would not be significant.

Effects on reservoir storage capacity from sediment accumulation would be similar to Lower Roach Gulch. Sediment accumulation in the reservoir should be slightly less than Lower Roach Gulch, however, because the delivery canal is shorter and would not intercept as many drainages. There would be a similar potential reduction in quantities of sediment in the lower Greybull River, approximately 20 to 25 acre-feet per year.

No Action

Without construction of a dam and reservoir, there would be no concerns about unique geologic or soils characteristics or responses to them. Sediment loads in the Greybull River resulting from runoff events in Roach Gulch and Blackstone Gulch would continue.

4.2.2 MINERAL RESOURCES

All federal lands with minerals are currently open to leasable and locatable mineral exploration. Should one of the action alternatives be approved and implemented, a No Surface Occupancy (NSO) stipulation would be attached to the land. Withdrawal of the lands from locatable minerals exploration would also be considered if one of the alternatives is implemented.

Lower Roach Gulch Alternative

Mineral resources that have been identified in the project area are limited to coal, sand and gravel. Coal deposits in this area are found in the Fort Union Formation which is located up to 2,500 feet below the surface. Currently it is not economically feasible to extract these coal resources because of the high overburden ratio. Creation of a reservoir at this site does not constitute a significant loss of opportunity to mine coal on these lands. Sand and gravel deposits at the site have not been developed. Construction of the reservoir and related facilities would require some of these materials and the potential for future development may be greater due to improved access.

Blackstone Gulch Alternative

Mineral resources at the Blackstone Gulch Alternative are also limited to coal in the Fort Union Formation and sand and gravel deposits. Impacts to leasable and locatable mineral resources are similar to the Lower Roach Gulch Alternative.

No Action Alternative

There would be no impacts to leasable and locatable mineral resources with the No Action Alternative.

4.3 WATER RESOURCES

4.3.1 SURFACE HYDROLOGY

4.3.1.1 Flow Reregulation

Lower Roach Gulch Alternative

The majority of water stored in the reservoir would be diverted during peak flows in the late spring and early summer. Some water would also be diverted from the Greybull River to the reservoir during the late fall and winter months, but diversions would be subject to a minimum flow bypass of 50 cfs at the diversion dam (M. O'Grady, SWWRC, pers. commun.). The net result of diversions to storage in the reservoir and releases for irrigation would be leveling of flows in the lower Greybull River Valley similar to effects of construction of Lower Sunshine Reservoir on Greybull River flows at the Meeteetse station (Figure 3.5).

Further leveling of flows would occur as a result of using the reservoir diversion canal to reregulate flows in the lower Greybull River during the irrigation season. Streamflow in the lower Greybull River currently fluctuates significantly on a daily basis (see Figure 3.4). The diversion canal would be used to divert daily flow peaks in excess of bypass requirements for minimum flows and downstream water rights up to canal capacity. Reservoir releases would be made during daily low flow periods to level flows in the lower Greybull River. Reregulation of the river would have significant benefits in conservation of irrigation supplies. Hourly streamflow modeling prepared by the WEST Team (WEST 1996b) indicates that benefits derived from reregulation of the river would depend on the diversion canal capacity.

Hourly flows in the Greybull River and diversions and releases for reregulation were modeled for the peak flow period from May through July of 1981 through 1990 and for diversion canal capacities of 500 and 1,000 cfs (Table 4.2). The Lower Roach Gulch Alternative includes a 1,000 cfs delivery canal; however, the Corps was also interested in modeling effects of a 500 cfs delivery canal. Benefits to canals downstream of the Lower Roach Gulch Reservoir from reregulation to level flows in the lower Greybull River with the 500 cfs diversion canal average approximately 287 acre-feet per year over the modeled period. At this size, there are fewer opportunities for reregulation because the diversion canal capacity (500 cfs) is near the average amount of natural flow that must be bypassed to meet downstream water rights (approximately 570 cfs).

Table 4.2 Benefits of reregulation and benefits to storage of using the diversion canal to regulate the natural daily flow fluctuations in the Greybull River.

Present Conditions (May through July Period, 1981-1990)											
Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Avg.
Natural Flow Diversions at Lower Greybull River Headgates (acre-feet)	93,126	88,472	89,590	63,162	89,173	92,185	87,873	84,551	75,979	81,173	84,528
Storage in Lower Basin Reservoir (acre-feet)	0	0	0	0	0	0	0	0	0	0	0
Lower Roach Gulch with 500 cfs Diversion Canal (May through July Period, 1981-1990)											
Natural Flow Diversions at Lower Greybull River Headgates (acre-feet)	93,377	88,692	89,610	63,561	89,823	92,287	88,077	84,608	76,238	81,874	84,815
Storage in Lower Basin Reservoir (acre-feet)	13,543	26,111	13,307	17,034	7,501	20,796	15,906	11,315	10,762	8,111	14,439
Benefits of Reregulation of Natural Flows (acre-feet)	251	220	20	399	650	102	204	57	259	701	287
Lower Roach Gulch with 1,000 cfs Diversion Canal (May through July Period, 1981-1990)											
Natural Flow Diversions at Lower Greybull River Headgates (acre-feet)	93,748	89,035	89,630	63,742	90,664	92,391	88,257	84,679	76,555	82,667	85,137
Storage in Lower Basin Reservoir (acre-feet)	13,543	27,769	13,331	17,034	8,151	20,796	16,423	11,266	11,027	8,882	14,822
Benefits of Reregulation of Natural Flows (acre-feet)	622	563	40	580	1,491	206	384	128	576	1,494	609
Benefits of Additional Canal Capacity to Reservoir Storage (acre-feet)	0	1,658	24	0	650	0	517	-49	265	771	384

Benefits of reregulation to level flows in the Greybull River with the 1,000 cfs diversion canal would be significant and average approximately 610 acre-feet per year over the modeled period. Larger daily flow peaks (see Section 3.3.1 Surface Hydrology) could be leveled with a 1,000 cfs canal due to the additional capacity over and above the bypass requirement.

The 1,000 cfs diversion canal also has benefits to reservoir storage over the 500 cfs canal. A 1,000 cfs diversion canal would allow storage on average of an additional 385 acre-feet of water per year in the reservoir over the modeled period. Total water supply benefits of the larger diversion canal would be approximately 995 acre-feet per year over the modeled period. Estimated benefits should be conservatively low because only a 3-month period of each year was used in the hourly modeling. In addition, average streamflow during the period of record used in the hourly modeling was only about 83 percent of the long-term average on the Greybull River. If the estimated benefits are adjusted to take into account the long-term average streamflow, the water conservation benefits of the 1,000 cfs diversion canal would be approximately 1,200 acre-feet per year. Benefits would also accrue if reregulation reduces the amount of labor required to reset headgates to maintain a constant diversion flow.

<u>Blackstone Gulch Alternative</u>

Effects analysis for river regulation and flow with either a 500 cfs delivery canal or a 1,000 cfs diversion canal would be similar to implementation of the Lower Roach Gulch Alternative.

<u>No Action</u>

With no lower valley reservoir in place, the present inefficiencies in the GVID's irrigation system would continue.

4.3.1.2 Timing of Irrigation Water Deliveries

<u>Lower Roach Gulch Alternative</u>

The timeliness of irrigation water deliveries would be enhanced with a storage reservoir in the lower Greybull River Valley. Under present conditions, with location of the current storage reservoirs more than 34 river-miles upstream of the major irrigation diversion structures, water orders must be placed substantially in advance of when the water is needed. A reservoir in the lower valley would cut travel time between the place of storage and place of use significantly and would increase system delivery efficiency. Storage in the lower valley would also allow capture of water released from the upper reservoirs when rain occurs between the time of the order and the time of use and the water ordered is no longer needed.

Blackstone Gulch Alternative

Implementation of the Blackstone Gulch Alternative would have similar effects for timeliness of irrigation water deliveries as would the Lower Roach Gulch Alternative.

No Action

The circumstances described in Chapter 3 would remain unchanged. There would be delays between a request for water and water delivery during which there could be substantial changes in river flow at the canal diversions resulting in water waste.

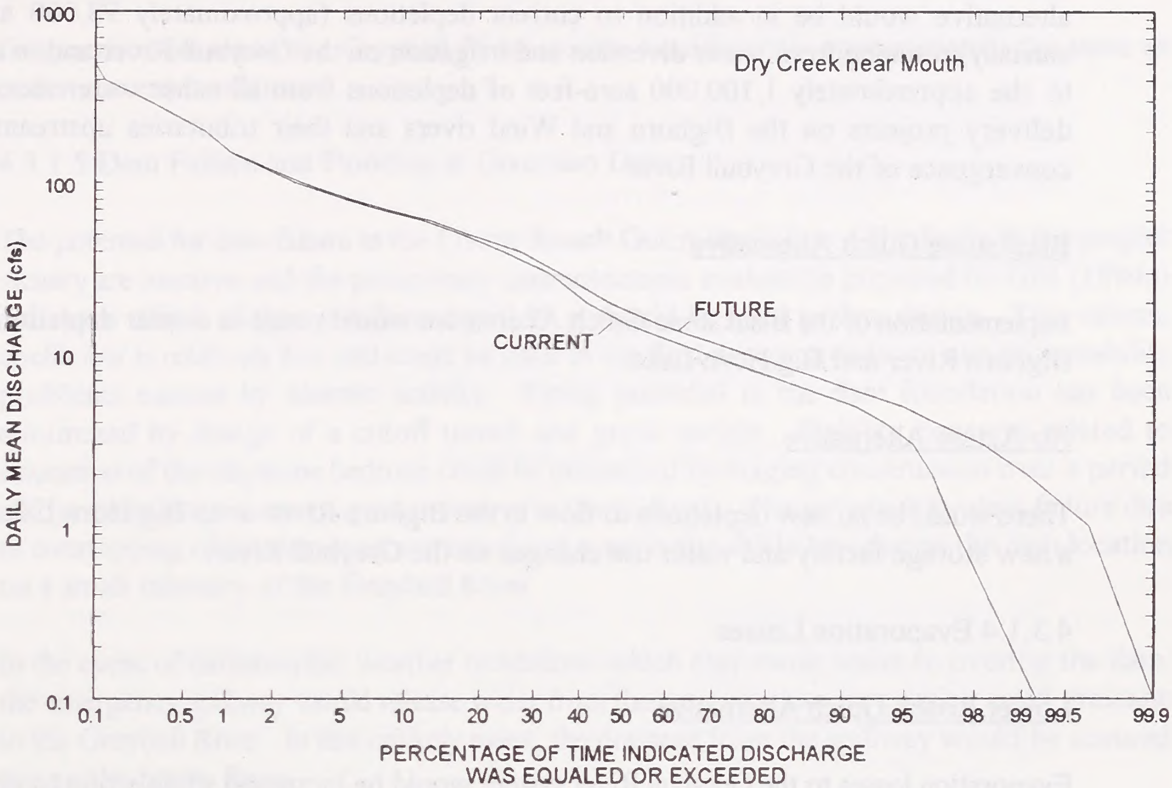
4.3.1.3 River System Depletions

Lower Roach Gulch Alternative

Operation of Lower Roach Gulch Reservoir would result in additional depletions at the mouth of the Greybull River due to both the use of more water on existing irrigated lands and a projected increase in irrigated lands (see Chapter 1). Since a substantial portion of the water provided by the project would be used to irrigate lands under the Bench Canal system, more water would be used on the Emblem Bench where return flows from irrigation flow to the Dry Creek drainage north of the Greybull River Valley (see Figure 1.1). As a result of this irrigation, low flows in Dry Creek would increase substantially, medium flows would increase by approximately 50 percent, and high flows would remain unchanged (Figure 4.1).

Figure 4.1 shows the current flow duration curve for Dry Creek based on measured daily flows at the mouth as well as the estimated future flow duration curve with the Lower Roach Gulch Reservoir in place. Estimates of future flows were made by adding additional return flows obtained from modeling of the system to current daily flows. Since most of the additional flow in Dry Creek would be contributed through increased groundwater discharge due to increased irrigation return flow from the Emblem Bench, the high flow regime in the creek would not be significantly affected. The channel-forming flows would remain approximately the same and the amount of erosion occurring in the stream channel would not be significantly affected. Increased return flows would result in a more stable base flow in Dry Creek. Increases in flow would primarily occur in low-flow periods when the flow in the creek is less than 5 cfs (Figure 4.1). There would also be slight increases in the occurrence of flows up to about 15 cfs. The occurrence of flows above 15 cfs would not be affected by the project. Average annual flow in Dry Creek is currently 23.3 cfs. Implementation of the project would increase the average annual flow to about 26.2 cfs.

Figure 4.1 Current and estimated future flow duration curves for Dry Creek



The SWWRC model (GEI 1994a) predicts that flows at the mouth of the Greybull River would be depleted by an average of 19,700 acre-feet per year and flows at the mouth of Dry Creek would be increased by an average of 11,550 acre-feet per year over current conditions. Net depletions to the Bighorn River and Big Horn Lake would be 8,150 acre-feet per year. Results of monthly modeling prepared by the WEST Team (WEST 1996b) indicate that flows at the mouth of the Greybull River would be depleted by an average of 5,480 acre-feet annually and flows at the mouth of Dry Creek would increase by an average of 2,120 acre-feet annually. Net increase in depletions to the Bighorn River and Big Horn Lake would be approximately 3,360 acre-feet annually under this use scenario. The primary difference between the two modeling efforts is in the estimation of current demands. The WEST Team model uses a current system demand that is slightly lower than the demand estimated by SWWRC and more closely represents the true current demand on the system. Carriage losses within the river system are also lower in the WEST Team model due to the availability of additional research data (Lewallen 1994). As a result, the WEST Team modeling provides a better estimate of the potential depletions resulting from addition of Lower Roach Gulch reservoir and operation of the project. The expected additional depletions to the Bighorn River due to operation of the Lower Roach Gulch Reservoir should be approximately the same as those estimated using the WEST Team modeling.

Depletions to the Bighorn River and to Big Horn Lake resulting from implementation of this alternative would be in addition to current depletions (approximately 98,000 acre-feet annually) resulting from water diversion and irrigation on the Greybull River and in addition to the approximately 1,100,000 acre-feet of depletions from all other water storage and delivery projects on the Bighorn and Wind rivers and their tributaries upstream of the convergence of the Greybull River.

Blackstone Gulch Alternative

Implementation of the Blackstone Gulch Alternative would result in similar depletions to the Bighorn River and Big Horn Lake.

No Action Alternative

There would be no new depletions to flow in the Bighorn River or to Big Horn Lake due to a new storage facility and water use changes on the Greybull River.

4.3.1.4 Evaporation Losses

Lower Roach Gulch Alternative

Evaporation losses to the Greybull River system would be increased slightly due to operation of the Lower Roach Gulch Reservoir. Evaporation from the reservoir was estimated using the SWWRC model and increases in evaporation from the canal system were estimated by the WEST Team (WEST 1996b). The total increase in evaporation due to operation of the reservoir would be approximately 1,660 acre-feet per year and the increase in evaporation due to delivery of additional water in the Greybull River and the existing canal system would be approximately 40 acre-feet per year. Total additional depletions to the system due to evaporation would be approximately 1,700 acre-feet per year. These depletions are included in the estimates of depletion to Big Horn Lake discussed above.

Blackstone Gulch Alternative

Evaporation losses to the system from operation of the Blackstone Gulch Reservoir should be similar to those from the Lower Roach Gulch Reservoir because the maximum surface area of both reservoirs is approximately 700 acres (GEI 1994a and 1994b). Blackstone Gulch is wider than Roach Gulch upstream of the proposed dam so evaporation may be slightly higher at lower reservoir storage volumes. Evaporation loss increases in the Greybull River resulting from releases from the reservoir would also be slightly greater than those for Lower Roach Gulch because of the greater distance from the reservoir to the point of use. Evaporation loss from the delivery canal would be less with this alternative because of its shorter length and because much of the delivery is through a tunnel. However, the contribution of the canal to evaporative losses with either alternative is negligible.

No Action Alternative

Evaporation losses to the Greybull River system would remain approximately the same as under current conditions.

4.3.1.5 Dam Failure and Flooding at Diversion Dam

The potential for dam failure at the Lower Roach Gulch site is low. The faults in the project vicinity are inactive and the preliminary seismotectonic evaluation prepared by GEI (1994a) indicates that a seismic coefficient of 0.10 g should be used in dam design. This seismic coefficient is relatively low and could be used in the final design process to minimize stability problems caused by seismic activity. Piping potential in the dam foundation has been minimized by design of a cutoff trench and grout curtain. Stability concerns related to saturation of the claystone bedrock could be minimized by staging construction over a period of 2 years to prevent excess pore pressures in the bedrock. The potential for dam failure due to overtopping of the dam in an extreme flood event is also fairly low due to the dam location on a small tributary of the Greybull River.

In the event of catastrophic weather conditions which may cause water to overtop the dam, the emergency spillway would release water from the reservoir into an existing small drainage to the Greybull River. In this unlikely event, the drainage from the spillway would be scoured due to the heavy flows.

Effects of a potential dam failure at the Lower Roach Gulch dam site were estimated by the WEST Team (WEST 1996b) using the National Weather Service Simplified Dam Break Flood Forecasting Model. This model indicates that, in the case of a rapidly developing breach in the dam, flood damages could be substantial in the town of Greybull. The Greybull River Valley floodplain downstream of the dam site is narrow enough to keep the flood peak from attenuating before it reaches the Bighorn River. The flood peak in the town of Greybull would occur approximately 6 hours after the dam begins to breach and would overtop the flood control dikes along the Bighorn River. Damages along the Greybull River would be restricted to farmsteads along the floodplain, as the area is sparsely populated.

The potential for flood damages caused by the redesigned diversion dam is small. The diversion dam was moved downstream from the originally proposed location to an area where there are no farm or ranch structures located immediately upstream of the diversion dam. The water surface elevation increase caused by the diversion dam during high flow events would not be great enough to cause additional flood damages to farms located upstream of the dam.

Blackstone Gulch Alternative

Effects of a dam breach at the Blackstone Gulch dam site would be similar to those at the Lower Roach Gulch site. The peak flooding to be expected at the town of Greybull would

probably be less, however, due to additional attenuation of the flood peak. Blackstone Gulch is located about 7 river-miles further upstream of Roach Gulch which would increase the travel time for the peak flow to reach the town.

The proposed diversion dam for the Blackstone Gulch Reservoir would not have the potential to increase flood damages. There are no buildings or farmsteads located immediately upstream of the site.

No Action Alternative

Without construction of a new storage facility or a diversion dam, there would be no potential for dam failure or flood damages associated with such facilities.

4.3.1.6 Potential for Hydropower Development

Lower Roach Gulch Alternative

The potential for development of hydropower in conjunction with the Lower Roach Gulch Alternative was analyzed by the WEST Team (1996b) using output from the Operations Study (OPSTUDY) models of the Greybull River Valley. Under the current plan for operation of the Lower Roach Gulch Reservoir, development of hydropower is not feasible. Average annual power production would be approximately 190,000 kilowatt-hours which, at current prices, would provide revenue of about $3,200 to $4,800 per year. Annual revenue in this range would not cover annual operating costs. The preliminary design for the reservoir outlet works includes provisions for adding a hydropower plant in the future if potential revenues increase to the point where hydropower is feasible. Changes in the operation of the reservoir, such as transfers of storage from Upper and Lower Sunshine reservoirs, could also be made to increase the hydropower potential. Making such changes could reduce irrigation efficiency and would also increase the cost of the outlet works which would have to be enlarged to allow passage of more water through the power plant.

Blackstone Gulch Alternative

There is even less potential for development of hydropower at the Blackstone Gulch site than at the Lower Roach Gulch site. The dam at Blackstone Gulch would be 115 feet in height as compared to a dam height of 150 feet at Lower Roach Gulch. As a result, the power generation head would be smaller while the amount of water released from the dam would be approximately the same. Total potential generating capacity would be significantly less.

No Action Alternative

Effects are similar to the action alternatives. There would be no new practical opportunities for hydropower development

4.3.2 WATER QUALITY

Water quality in the Greybull River may be affected by construction and operation of a reservoir in the lower valley, but it is unlikely that effects would be significant. Water quality in the river is presently acceptable, even during low-flow periods, for irrigation and stock-watering uses which comprise the majority of current water uses in the valley. Changes in water quality due to operation of a lower valley reservoir would be related to quantity of storage developed, length of time that water would be held in the reservoir before being released, and purpose for which the water was used.

4.3.2.1 Total Dissolved Solids

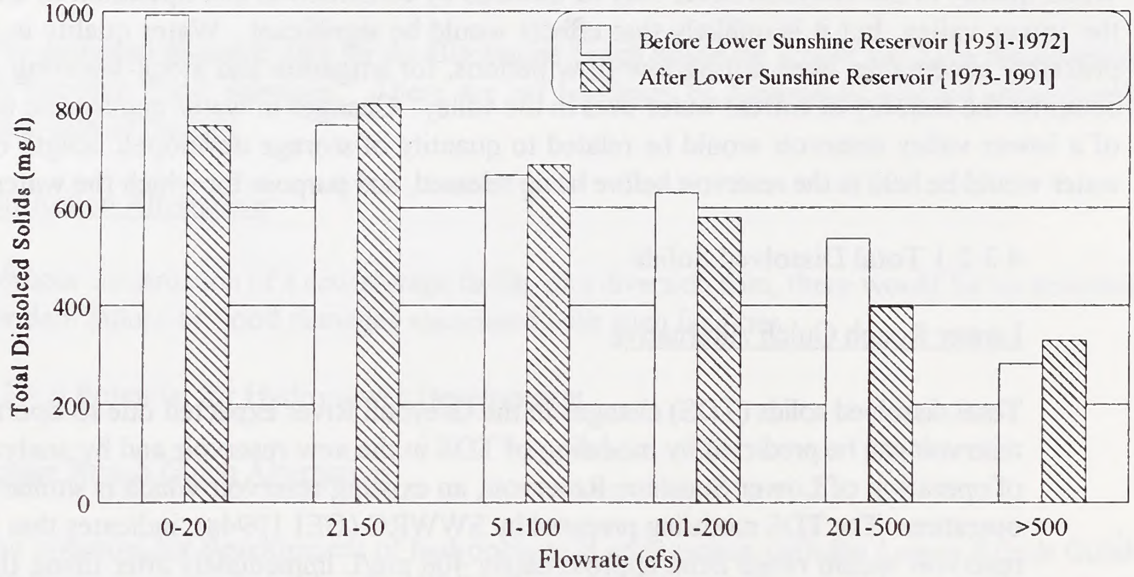
Lower Roach Gulch Alternative

Total dissolved solids (TDS) changes in the Greybull River expected due to operation of the reservoir can be predicted by modeling of TDS in the new reservoir and by analyzing effects of operation of Lower Sunshine Reservoir, an existing reservoir which is similar in size and operation. The TDS modeling prepared by SWWRC (GEI 1994a), indicates that TDS in the reservoir would range from approximately 400 mg/L immediately after filling the reservoir in June to approximately 700 mg/L at the end of April before the filling period begins (GEI 1994a). Releases from the reservoir should be within the range of normal TDS values in the reach of river where the reservoir is located (Robinove and Langford 1963).

Changes in TDS expected in the lower portion of the valley due to use of additional reservoir water can be predicted by analyzing effects of adding Lower Sunshine Reservoir to the system in 1972. As is shown by modeling of TDS in the proposed Lower Roach Gulch reservoir, changes in TDS due to storage of water are minimal. Most TDS changes in the river would occur due to application of stored water to the irrigated land and return flows from irrigated land to the river. Changes due to irrigation application would be similar for both Lower Sunshine and the Lower Roach Gulch reservoirs because most of the additional water supplied by the reservoir would be used on land that is currently irrigated. The TDS data are available at the Greybull River near Basin Station for various periods from 1951 through 1991 (Figure 4.2; EPA 1995). Changes in TDS concentrations are not statistically significant for most of the flow ranges shown; however, there is a significant decrease in TDS concentration at very low flows (less than 20 cfs) when the majority of water in the river consists of return flows from irrigation.

The decrease in TDS at low flows is probably due to an increase in the use of water on lands over the Greybull River alluvium in the lower portion of the valley and a corresponding increase in water table elevations and return flows. The increase in the water table elevation in the alluvium increases the hydraulic gradient from the alluvium to the river and, therefore, increases the velocity of flow through the alluvium. Since the water moves from the alluvium to the river more quickly, it is in contact with the underlying Willwood Formation for a shorter period and dissolves fewer solids from the formation.

Figure 4.2 Average TDS concentrations at the Greybull River near Basin station for the periods before and after construction of Lower Sunshine Reservoir.



Another mechanism that may explain part of the decrease in TDS is that as more high quality water is used on the same lands, there is a dilution effect on the leaching of minerals from the irrigated soils and a decrease in the TDS concentration of return flows. Both mechanisms should be in effect with the use of additional water from a lower valley reservoir and approximately the same effects on TDS, ranging from a decrease in TDS at lower flows to insignificant changes at higher flows, should be seen.

Overall, TDS and the components of TDS are not sufficiently high to cause adverse effects to aquatic life in the Greybull River. Changes in TDS would need to be increased and sustained at more than 15,000 mg/L before adverse effects to fish or other aquatic life are expected (EPA 1976, 1986a). This scenario is highly unlikely because the additional volume of water supplied by the project on an annual basis is only about 10 percent of the volume already applied.

Effects of the project on TDS concentrations in Dry Creek are likely to be similar to those expected for the lower Greybull River. Robinove and Langford (1963) found that return flows from the Emblem Bench have a dilution effect on TDS concentrations in Dry Creek. Streamflow in the upper portion of Dry Creek above the irrigation return flows has high TDS concentrations (3,000 to 10,000 mg/L). The return flows from the Emblem Bench reduce the TDS concentrations of the mixed flows by 1,000 to 1,500 mg/L. Additional application of irrigation water to the Emblem Bench would increase the quantity of return flow to Dry Creek and have a further dilution effect, thereby reducing the TDS of flows in Dry Creek.

The TDS concentrations in the Bighorn River below the mouths of the Greybull River and Dry Creek and in Big Horn Lake would most likely be slightly reduced as a result of the project. Reductions in the TDS concentrations of inflows from the Greybull River and Dry Creek could have a positive effect on TDS concentrations of the Bighorn River below the inflow points. Since these inflows are very small during the portions of the year when reduced TDS concentrations are significant, the net effect on the much larger flows in the Bighorn River would be very small and difficult to quantify. The significance of impacts in the Greybull River and Dry Creek are difficult to determine because of the wide range of TDS concentrations that occur in both streams and because the effects of the project are expected to be minor.

Blackstone Gulch Alternative

Effects would be similar to Lower Roach Gulch with insignificant changes in TDS.

No Action Alternative

There would be no changes in TDS associated with operation of a new reservoir.

4.3.2.2 Sediment Loading

Lower Roach Gulch Alternative

Implementation of the Lower Roach Gulch Alternative would have variable effects on sediment loading and distribution within the lower Greybull River. The diversion dam and pool could act as a sediment trap for water coming from upstream by decreasing velocities, allowing suspended sediments to settle out of the water column, and possibly improving the clarity of flows passing the diversion dam.

The design of the diversion dam prepared by SWWRC and Woodward-Clyde Consultants (1996) was reviewed by the WEST Team. The diversion dam has been designed with overflow gates in the main channel of the river located at approximately the current elevation of the channel bottom. During high flows, the gates will lie flat and allow free run of the river through the dam. During low flows in the river, the gates will be raised to create sufficient head to allow diversion through the canal while still bypassing the required flows downstream. Maximum height of the overflow gates in the main channel is 6 feet which would minimize the size of the diversion pool even during very low flows. In both cases, velocities in the main channel would exceed those to the diversion canal and would carry the majority of suspended sediment and bedload through the diversion dam. The minimum flow bypass of 50 cfs during the winter months and the required bypass to meet downstream water rights of the natural flow up to 570 cfs during the irrigation season would be sufficient to carry nearly all of the sediment on through the small diversion pool.

Any sediment that accumulates upstream of the diversion dam would have to be removed periodically in order to maintain the diversion pool capacity. Removal of sediment could be accomplished either while routing streamflow around the area to be disturbed, if sediment removal is done during periods when the sediment concentration of the river is low, or while sediment concentration in the river is high so that increases due to removal operations are insignificant.

The off-channel reservoir would be the primary sediment trap. Modeling done by SWWRC (1996a) indicates that approximately 13.7 acre-feet per year of sediment would be diverted from the Greybull River through the diversion canal along with the reservoir inflows. In addition, estimates of sediment production from the gulches crossed by the canal and drainage basin of the reservoir site indicate that approximately 14.9 acre-feet per year of sediment from other drainages would be trapped in the reservoir (WEST 1996b).

Relatively clear, sediment-free water that may be "sediment hungry" would be discharged from the off-channel reservoir. The "sediment hungry" water may transport the finer materials (suspended load) out of the system leaving the larger (bedload) substrates in the reservoir. These latter deposits have the greatest potential for causing degradation to the reservoir outlet channel and river channel downstream of the discharge point. Degradation refers to the geologic process by which streambeds and floodplains are lowered in elevation by removal of material. The degradation process often occurs downstream of water storage projects (Simons and Senturk 1977, Leopold et al. 1995, Gordon et al. 1994). These physical processes may cause a condition known as armoring. However, water discharged from the reservoir would be released during the irrigation season when natural flows of approximately 570 cfs (if available) would be bypassed at the diversion dam unless the diversion canal and reservoir are primarily used for reregulation. Releases would mix with the natural flows immediately after being discharged into the river and would minimize potential degradation. In general, operation of the diversion dam and reservoir should decrease sediment transport in the river but not significantly enough to cause erosion problems.

Effects of project implementation on sediment loading in Dry Creek would be minimal. The primary effect of the project would be an increase in flow downstream of the area of return flow from irrigation on the Emblem Bench. The increased flow would consist primarily of increased groundwater discharge to the stream which would decrease the overall sediment concentration of the stream. Additional flows would not significantly increase erosion and, therefore, sediment transport in the Dry Creek channel because they would primarily influence the low-flow portion of the hydrograph (below 5 cfs) and would not significantly affect the higher channel-forming flows.

As discussed previously, the damming of Lower Roach Gulch and diversions of sediment from the river to the reservoir through the diversion canal would reduce sediment loading in the Greybull River. Some increases in sediment transport may occur downstream from the reservoir depending on operation of the reservoir and method of water use on irrigated lands

that drain to the Greybull River. For example, converting idle lands into irrigated crop lands may increase sediment loading in surface runoff by reducing vegetative cover of the land. Effects of these potential changes would tend to cancel each other and the effect on the Bighorn River is difficult to quantify, particularly since there is very little available data on current sediment discharge from the Greybull River.

Blackstone Gulch Alternative

Effects of implementation of the Blackstone Gulch Alternative would be similar to Lower Roach Gulch.

No Action Alternative

There should be little change in existing sediment transport in the Greybull River under this alternative.

4.3.2.3 Turbidity

Lower Roach Gulch Alternative

Turbidity in water released from a Lower Roach Reservoir may be greater than turbidity in the receiving Greybull River during the late irrigation season. The potential for increased turbidity is based on geotechnical surveys of the reservoir basins conducted by GEI (1994a), which identified dispersive clays in the Willwood Formation surrounding the reservoir site. These clays could be released into the reservoirs through runoff from intense local storms in the reservoir basin, wave erosion of the sides of the reservoir basin, or rapid drawdown of the reservoir. The potential for large increases in turbidity due to runoff from local storms is low because the reservoir site is located in an area of very low annual precipitation and low thunderstorm frequency (Martner 1986). The potential for increases in turbidity due to wave erosion is low due to the sheltered location of the reservoir basin. The high-water lines of the reservoir would be below the surrounding topography and the surface of the reservoir would be protected from high winds. The reservoir site is also located where average annual wind speeds are low (Martner 1986); therefore the potential for large or frequent wind-generated waves is low. Rapid drawdown of the reservoir could increase turbidity of the reservoir water due to movement of water along outcrops of dispersive clays during the drawdown process.

Turbidity of water released from the reservoir should not be sufficient to cause significant increases in turbidity of the Greybull River. As discussed in Chapter 3, turbidity of the Greybull River is highly variable and related to suspended sediment concentrations. Reduction of suspended sediment through operation of the diversion dam and reservoir should also reduce turbidity in the river, although the reductions may be small and difficult to quantify. Turbidity below the reservoir site is anticipated to be equal to or less than turbidity in the river upstream of the diversion dams.

Turbidity in Dry Creek would most likely be decreased by implementation of the project. The majority of increased flows in Dry Creek would come from increases in groundwater discharge to the stream and would be very low in turbidity.

Turbidity of the Bighorn River would not be affected by the project because inflows from the Greybull River and Dry Creek as well as many other tributaries of the Bighorn are currently highly turbid during the runoff period. During low-flow periods, inflows from the Greybull River and Dry Creek are very small compared to flow in the Bighorn River. Even a large increase in turbidity of low-flow inflows from the Greybull River and Dry Creek would be insignificant when inflows are mixed with flow in the Bighorn River.

Actual construction of the diversion dam and of other alternative components could temporarily contribute to increased sediment loading and turbidity in the Greybull River in the event of a major storm event. Implementation of good erosion and stormwater runoff control practices during construction would minimize these increases. There is also potential for some sediment loading and turbidity increase upon first use of the reservoir discharge system. This potential could be minimized by scheduling the first releases during the spring runoff period when turbidity and sediment loading in the Greybull River are already high.

Blackstone Gulch Alternative

Effects would be similar to implementation of Lower Roach Gulch.

No Action Alternative

There would be no new changes to turbidity levels in the Greybull River.

4.3.2.4 Other Water Quality Concerns

Lower Roach Gulch Alternative

Conventional pollutants, metals, organics, and nutrients which have been monitored at the Greybull River near Basin station are summarized in Table 3.2. Increases in concentrations of these chemicals are not expected to occur during construction and operation of the alternative. Additional water supplied by the Lower Roach Gulch Alternative during the irrigation season may increase the potential for pesticide use in the lower Greybull River Valley due to increases in acreage of high-value crops that require additional pesticide use. For example, with an increase in bean production in the valley there may be an increase in use of phenolic compounds used as fungicides. Historic data from the 1960s indicated that phenol concentrations in the Greybull River were approximately one-half the human health standard (Table 3.2). However, these measures were recorded prior to regulatory criterion of phenols. There is no information available to indicate that current concentrations of phenol

exceed WDEQ standards. The lower valley currently has a substantial acreage of high-value crops, and pesticide concentrations have not been found at levels which would cause concern.

There is very little data available on concentrations of conventional pollutants, metals, organics, or nutrients in Dry Creek. Effects of additional irrigation on the Emblem Bench on water quality in Dry Creek would be similar to those expected for the lower Greybull River.

Some leaching of salts, sulfates, or selenium would occur, especially when the reservoir is first filled and soils are exposed to reservoir water; however, long-term increases of these materials in reservoir water should be small as these materials are leached out of the soil and an equilibrium is established. Furthermore, selenium has only been found to accumulate to concentrations that pose a risk to aquatic life in closed basins; therefore, the probability that it would accumulate to high concentrations in any reservoir that is drained annually, such as the off-channel alternatives for this project, is quite small.

Groundwater quality should be affected in a similar manner as surface water. A slight improvement in groundwater quality may occur at the lower end of the valley due to expected improvement in the quality of irrigation return flows.

Blackstone Gulch Alternative

Effects would be similar to Lower Roach Gulch.

No Action Alternative

There would be no changes in water quality from current conditions.

4.3.3 GROUNDWATER HYDROLOGY

Lower Roach Gulch Alternative

Changes in groundwater availability due to operation of the Lower Roach Gulch Alternative should be positive. The majority of water from the proposed reservoir would be applied to currently irrigated lands to increase production. Since the source of recharge of the terrace and alluvial aquifers in the lower Greybull River Valley is primarily irrigation (Robinove and Langford 1963), water levels in the Emblem terrace deposits, the Greybull terrace deposits, and the Greybull River alluvium should rise. The increase in water levels could increase yields from wells in these aquifers.

Some potential recharge to aquifers in the Willwood Formation may occur as a result of operation of the proposed reservoir. It is more likely, however, that water introduced to the sandstone layers of the Willwood Formation would return to the reservoir as it is drawn down. Since the reservoir would be drained annually, the amount of recharge that would accrue to the Willwood aquifers is probably insignificant.

Blackstone Gulch Alternative

Effects of implementation would be similar to those for Lower Roach Gulch.

No Action Alternative

There would be no change from current conditions. There would be no rise in groundwater levels in the project vicinity.

4.3.4 WATER RIGHTS

Lower Roach Gulch Alternative

Potential effects on existing water rights in the lower Greybull River Valley due to operation of the Lower Roach Gulch reservoir are positive. The reservoir would have a later priority water right than all other existing water rights in the Greybull River Valley. The reservoir would provide additional supplies to shareholders in the reservoir with lands located in the valley. Return flows from irrigation with reservoir water would become available to other water users downstream as additional supplies. Additional supplies would also become available to irrigators on Dry Creek due to increased return flows from the Emblem Bench.

Exchanges of reservoir water for natural flow could be used to provide supplies to irrigators upstream of the proposed reservoir. The upstream user could divert natural flow that would otherwise be bypassed to higher priority rights downstream in exchange for releases from the reservoir to meet the needs of the downstream user. Exchanges could potentially have an adverse effect on flows in the river between the upstream user and the reservoir diversion, but since the majority of senior water rights in the valley are located downstream of the reservoir and approximately 570 cfs must be bypassed at the reservoir to meet downstream rights, the river should not be affected significantly.

Water supplies to water rights downstream of the reservoir may be increased when the diversion canal and reservoir are used for reregulation. Regulation of flows to eliminate daily peaks would make operation of downstream headgates more efficient and increase water supplies.

Blackstone Gulch Alternative

Effects would be similar to implementation of the Lower Roach Gulch Alternative.

No Action Alternative

There would be no change in the existing operation of the irrigation system, storage releases, and bypass necessary to satisfy existing water rights.

4.4 AIR QUALITY

Lower Roach Gulch Alternative

Due to the current good air quality in the region, construction of the reservoir would have only a minor, temporary effect on air quality at this proposed reservoir site. During construction, earth-moving equipment would create some fugitive dust. In addition, areas where vegetation is removed at borrow sites, the dam site, and canal route would be susceptible to wind erosion and could also produce fugitive dust. Both of these sources of fugitive dust would temporarily increase the Total Suspended Particles (TSP) load in the immediate project area. The magnitude of this increase would depend on weather conditions during and following construction and success of water-spreading operations during construction.

Construction equipment also would produce exhaust emissions. It is possible that brush and other vegetation removed from construction sites would be piled and burned if a burn permit is issued for this purpose. These emissions would be temporary in nature and would dissipate quickly.

After construction is completed and all disturbed areas are reclaimed, fugitive dust and exhaust emissions would cease. Following construction, the main potential air quality impact would occur during reservoir drawdown, when exposed soils could produce dust during dry, windy conditions.

Indirect and cumulative effects to air quality would be from dust that may arise from increased travel on dirt roads to and from the site during its operation and increased agricultural activity in the valley due to the supplemental irrigation water supplies. Fugitive dust and equipment emissions generated as a result of this alternative are not expected to have a significant effect on local air quality.

Blackstone Gulch Alternative

Due to the similar nature of this alternative, construction of the reservoir at this site would have the same impact on air quality as the Lower Roach Gulch Alternative. Because this reservoir would be slightly larger than Lower Roach Gulch (~730 vs 675 acres), more fugitive dust could be created during reservoir drawdown at this location. Construction of the tunnel could create more fugitive dust than construction of a delivery canal only, otherwise overall effects would be similar.

No Action Alternative

No new impacts to air quality are expected to occur under the No Action Alternative.

4.5 NOISE

Lower Roach Gulch Alternative

Construction activity would occur yearlong for an approximately 2-year period (GEI 1994a). During construction, operation of heavy equipment and associated support vehicles would increase noise in the project area. Equipment used during construction of this project (bulldozers, graders, cranes, trucks) typically produce noise levels of 80 to 90 decibels (dBA) at a distance of 50 feet (Table 4.3). When several pieces of construction equipment are operating simultaneously in the same area, peak noise would be approximately 93 dBA at 50 feet, and areas within 1,500 feet of the construction zone could experience noise levels exceeding 60 dBA. Noise associated with construction equipment would likely be restricted to daytime hours, and would be temporary in nature. The closest noise receptors of concern in the Lower Roach Gulch project area are two residences located within 1 mile north of the construction zone. Noise at these locations would be less than 60 dBA (Table 4.3). Construction of the diversion dam and related facilities and the delivery canal would produce similar noise, but with fewer pieces of equipment and shorter duration of noise generation at any one location. The YU Ranch headquarters near the diversion dam location is the closest receptor area, about 300 yards distant. Noise at the ranch would be less than 60 dBA (Table 4.3).

Table 4.3 Typical noise levels (dBA) associated with construction equipment.

	Estimated dBA at Distance From Source					
	15 meters	30 meters	46 meters	61 meters	76 meters	91 meters
Activity						
Clearing	83	77	73	71	69	67
Grading	75-88	69-82	65-78	63-76	61-74	59-72
Paving	72-88	66-82	62-78	60-76	58-74	56-72
Erection	72-84	66-78	62-74	60-72	58-70	56-68
Types of Equipment						
Bulldozer	77-96	71-90	67-86	65-84	63-82	61-80
Dump Truck	82-94	76-88	72-84	70-82	68-80	66-78
Scraper	80-93	74-87	70-83	68-81	66-79	64-77
Paver	86-88	80-82	76-78	74-76	72-74	70-72
Crane	75-85	69-79	65-75	63-73	61-71	59-69

Other potential noise receptors of concern include sage grouse on leks, big game on crucial winter ranges, and nesting raptors. No grouse leks or crucial big game winter ranges are known to occur in the vicinity of the project. One golden eagle, one ferruginous hawk, one American kestrel, and one prairie falcon nest have been documented or are suspected to occur in the project area within 0.5 mile of proposed construction activities. If construction occurs during the nesting period (March through July), increased noise levels could disturb these individuals. Impacts would be considered

significant if disturbance from construction caused a pair of raptors to abandon their nesting effort for the year. Following completion of construction activities, noise levels should return to the same levels as those that existed prior to construction, with the exception of occasional maintenance and service vehicles visiting the dam site.

Primary existing local noise sources are farm equipment and intermittent highway traffic which are common. No significant indirect or cumulative effects are anticipated associated with noise generated by implementation of this alternative over the 2-year construction period. However, during seasonal use of farm equipment in the Greybull River Valley, there would be a slightly larger area in which species sensitive to noise may be disturbed.

Blackstone Gulch Alternative

Construction of the proposed reservoir at this site generally would produce the same noise levels as the Lower Roach Gulch Alternative during and following the construction period. Additional noise associated with this alternative may come from blasting or drilling the tunnel for the canal route. The closest potential noise receptors are a golden eagle nest and kestrel nest on the cliff face through which the tunnel would be drilled, a golden eagle nest along the Greybull River within 0.5 mile of the return flow route, and the YU Ranch headquarters near the diversion dam and tunnel locations. If construction occurs during the nesting period, increased noise levels could disturb nesting raptors. If nest abandonment occurs, the disturbance would be considered significant. The next closest noise receptors of concern in the Blackstone Gulch Project area are two residences located within 1 mile of the construction zone. No grouse leks or crucial big game winter ranges are known to occur in the vicinity of the site. Other effects would be similar to the Lower Roach Gulch Alternative.

No Action Alternative

No changes in ambient noise levels are expected to occur under the No Action Alternative.

4.6 BIOLOGICAL RESOURCES

4.6.1 WETLANDS

For the reservoir alternatives, there is the potential for wetland impacts to occur in four different locations: the reservoir site including the dam site and area inundated with water; the canal route from the Greybull River to the reservoir site; the return flow route from the reservoir to the Greybull River; and along the Greybull River between the diversion canal and point of return flow due to potential reduced flows.

The proposed project would result in a change in the agricultural practices in the Greybull River Valley (see section 4.7 LAND USE). It is anticipated that additional acreage would be put into crop production and a change in cropping patterns would result following project implementation. These

changes would necessitate changes in irrigation practices in the valley with an overall net increase in the amount of water used for irrigation. The resulting change in the water regime in the valley would undoubtedly affect some wetlands which are not located in the project vicinity or area of construction (e.g along Dry Creek). Without knowing specific changes that may result from the increase in irrigation water (that is, the location and number of new fields put into crop production and location and number of fields with a crop change) the extent of effects on wetlands in the valley cannot be accurately estimated. However, it is anticipated that this change in agriculture practices and increased acreage farmed would result in a net increase in wetlands because of a net increase in water available to wetlands that result from seepage along irrigation canals, irrigation practices, or return flows to the Greybull River and Dry Creek. Wetlands created from irrigation practices are typically considered low value and most are not jurisdictional under the CWA.

Lower Roach Gulch Alternative

Construction of the proposed reservoir at this site would inundate a 1.8-acre stock pond. Construction of the reservoir would also result in the loss of approximately 0.36 acre of wetland along the intermittent streambed of the gulch. Approximately 0.28 acre of wetlands exist along the proposed 5-mile-long canal route from the Greybull River to the reservoir site. Excavation of the canal route to provide for increased flows to the reservoir would impact these wetland communities. Approximately 0.60 acre of wetland would be inundated along the Greybull River behind the diversion structure. This wetland is comprised of sandbar willow habitat on a small sandbar and a secondary channel dominated by creeping spikerush. Construction of the return flow route to the river from the reservoir would require excavation in approximately 0.57 acre of wetland while widening and stabilizing the existing channel to withstand increased flows (Table 4.4).

Table 4.4 Comparison of wetland acreage potentially impacted by each of the reservoir alternatives

Project Component	Lower Roach Gulch Reservoir	Blackstone Gulch Reservoir
Reservoir Site	0.36 acre streambed 1.80 acres stock pond	0.04 acre streambed 0.51 acre stock pond
Diversion Canal Route	0.88 acre	0.40 acre
Return Flow Route	0.57 acre	0.02 acre
Greybull River from Diversion to Return	1.15 acres	1.46 acres
Total	4.76 acres	2.43 acres

There are approximately 165.43 acres of wetlands within the Greybull River riparian corridor between the diversion point and return flow point. Based on HEC-RAS modeling, approximately 309.12 acres are flooded during a 2-year flood event between the diversion point and return flow point for the Lower Roach Gulch Alternative. With a 1,000 cfs diversion, approximately 266.40 acres would be

flooded, a reduction of 42.72 acres (13.82 percent). Results of HEC-RAS modeling and wetland mapping indicate that approximately 1.15 acres of wetlands maintained by river flooding could be impacted by reduced flows in the Greybull River during diversion (Table 4.4; WEST 1996c).

Under this alternative, a total of approximately 4.76 acres of wetland would be impacted (Table 4.4). Seepage and higher groundwater levels associated with the presence of a reservoir may offset some of this impact. In addition, wetlands may form around the reservoir edge and along canal routes associated with the new reservoir. The extent of new wetlands created around the reservoir is expected to be similar to wetland formation around Upper and Lower Sunshine reservoirs. Wetland surveys at these two reservoirs indicated that approximately 36 acres of wetlands occur around the fringes of Upper Sunshine, and approximately 111 acres of wetlands are present around the fringes of Lower Sunshine Reservoir (WEST 1995b). Similar wetland formation should occur around the edge of the new reservoir. The project should result in a net increase in wetland acres in the area.

Although wetlands would be formed in association with the reservoir, the function and value of these wetlands would not be as high as those wetlands potentially lost as a result of reservoir construction, especially those wetlands along the Greybull River. Wetlands along the river are quite diverse and many contain several layers of vegetation (for example, cottonwoods, willows, herbaceous layer). These wetlands provide excellent wildlife habitat, improve water quality and stabilize shorelines along the river. Based on observations at Upper and Lower Sunshine Reservoir, wetlands forming along the shoreline of the new reservoir would consist primarily of wetland species such as biennial wormwood, foxtail barley, curly dock, and baltic rush growing in association with annual weeds such as Canada thistle, curlycup gumweed, and sweetclover at very low densities. These wetlands provide little wildlife habitat and do little to improve water quality or stabilize shorelines in comparison to those wetlands along the river.

The canal to the reservoir site would deliver water to the upper reaches of the gulch near the southwestern corner of the reservoir. Water would be delivered straight to the existing channel which may result in wetland formation along this portion of the gulch.

Indirect effects of project implementation on wetland acreage may occur from additional irrigation of existing farmland and any newly cultivated lands. There may be an increase of lowland seeps associated with increased irrigation that could, over time, enhance or support new wetlands. In addition, increased return flow into Dry Creek may enhance wetland communities along that stream. Because of increased return flows due to implementation of the project, it is assumed that wetlands along the lower reaches and the mouth of the Greybull River would not be affected.

Impacts to wetlands associated with the Greybull River corridor have occurred through construction of roads, irrigation systems, and establishment of farms. Because many of these changes occurred with settlement of the valley, it is uncertain what the total wetland loss may have been. On the other hand, return flows from irrigation, and seeps and springs resulting from a higher water table due to cropland irrigation have also contributed to enhancement or formation of new wetlands. The short-term cumulative effect will be additional wetland loss from this project coupled with all previous

wetland loss in the vicinity of the Greybull River. The expected long term cumulative effect would be a net gain in area wetlands as new wetlands form in association with operation of the reservoir and application of additional irrigation water to project lands.

Blackstone Gulch Alternative

Construction of the proposed reservoir at this site would inundate and result in the loss of three stock ponds totaling 2.2 acres. Portions of the 1.6-acre "Friday the 13th Reservoir" have been fenced to exclude livestock and have extensive wetland vegetation. Approximately, 0.51 acre of wetland are associated with these ponds (WEST 1996c). Approximately 0.04 acre of wetland occurring along the intermittent streambed of Blackstone Gulch would be inundated by this alternative. An additional 0.02 acre of wetlands exist along the return flow route where excavation would be required. No wetlands occur along the proposed canal route (and tunnel) from the Greybull River to Blackstone Gulch, however, approximately 0.40 acre of riparian wetland would be inundated along the Greybull River behind the diversion structure (Table 4.4).

There are approximately 79.75 acres of wetlands within the Greybull River riparian corridor between the diversion point and return flow point. Based on the HEC-RAS modeling, approximately 240.62 acres are flooded during a 2-year flood event between the diversion point and return flow point for the Blackstone Gulch Alternative. With a 1,000 cfs diversion, approximately 217.88 acres would be flooded, a reduction of 22.74 acres (9.5 percent). Results of the HEC-RAS modeling and wetland mapping indicate that approximately 1.46 acres of wetlands maintained by river flooding could be impacted by reduced flows in the Greybull River during diversion (Table 4.4; WEST 1996c).

Under this alternative, a total of approximately 2.43 acres of wetland would be impacted (Table 4.4). As with the Lower Roach Gulch Alternative, seepage and higher groundwater levels associated with the presence of a reservoir may offset some of this impact. Wetland formation around the fringe of this reservoir would be similar to Lower Roach Gulch. Overall, there would be a net increase in the acreage of wetlands in the project vicinity. The potential for wetland development along the delivery canal to this reservoir is much lower than that for Lower Roach Gulch due to the topography at the terminal end of the canal. Delivered water would enter the reservoir site at approximately the high-water line. There is no natural drainage for the delivered water to flow through to the reservoir. Indirect and cumulative effects are expected to be similar to the Lower Roach Gulch Alternative.

No Action Alternative

Under the No Action Alternative, no impact to wetlands would be expected, and no net increase in wetland acreage in the project area would occur.

4.6.2 VEGETATION

4.6.2.1 Plant Communities

Lower Roach Gulch Alternative

Construction of the reservoir at this site would result in permanent loss of vegetation in the area inundated where the dam, appurtenant structures, and roads are constructed. Temporary alterations to plant communities would result from clearing adjacent to construction zones and excavating within borrow areas that would not be inundated.

Inundation and construction of the dam and associated structures would result in the loss of approximately 551 acres of mixed grassland-sagebrush shrubland, 19 acres of mixed riparian shrub-shrub steppe community, and 105 acres of sparsely vegetated rocky outcrops and ridges. Clearing and excavation within adjacent borrow areas would result in additional loss of 1,025 acres of upland habitats primarily comprised of mixed sagebrush-grassland shrubland. Due to soil types, thin soils, high erosion potential, and low precipitation, successful revegetation of these areas would be difficult. With application of special reclamation practices designed to address these factors (see Chapter 5.0 MITIGATION) and including application of native seed, loss of these communities would be relatively short-term in nature (approximately 2 to 3 years).

Because construction of the reservoir would result in a more dependable water supply, approximately 15 percent of GVID members indicated that they would irrigate additional acreage under water right but not currently in crop production. This increase in irrigated acreage would result in the conversion to irrigated crop of approximately 1,400 acres not currently irrigated (see Chapter 1). These areas are scattered throughout the Greybull Valley Irrigation District and their exact locations are not known at this time. This additional acreage is probably fallow land (subject to previous tillage) and additional loss of high quality native upland habitats would probably not occur under this alternative.

Blackstone Gulch Alternative

Construction of the reservoir at this site would result in similar impacts to vegetation as Lower Roach Gulch. Inundation and construction of the dam and associated structures would result in the loss of approximately 680 acres of mixed grassland-sagebrush shrubland, 16 acres of mixed riparian shrub-shrub steppe community, and 34 acres of sparsely vegetated rocky outcrops and ridges. Clearing and excavation within adjacent borrow areas would result in additional loss of upland vegetation. Although borrow areas for this reservoir have not been identified, they would likely be similar in size and in similar habitat types as borrow areas for the Lower Roach Gulch Alternative. Loss of these communities would be relatively short-term in nature following successful reclamation of disturbed areas. Concerns about revegetation/reclamation success are the same as with Lower Roach Gulch. As with Lower

Roach Gulch, construction of the reservoir in Blackstone Gulch also would provide sufficient water to convert 1,400 acres of currently nonirrigated fallow land into crop production.

No Action Alternative

Under the No Action Alternative, impacts to vegetation would not be expected at the proposed reservoir site, and additional acreage would not be put under irrigation.

4.6.3 WILDLIFE

4.6.3.1 Mammals

Lower Roach Gulch Alternative

Construction of the reservoir in Lower Roach Gulch would result in the loss of approximately 675 acres of upland habitats through construction of the dam and related facilities and inundation from the reservoir. An additional 1,025 acres would be lost at borrow areas during reservoir construction. The area impacted by the reservoir and borrow areas represents far less than 1 percent of that habitat type available in the Greybull Valley, and this loss would not likely result in a significant impact to any mammalian populations in the valley. This loss would cause a decrease in the local abundance of some smaller mammals that occupy the habitat types inundated. Inundation of the reservoir would drown some smaller relatively nonmobile species such as rodents and other small mammals (Goldsmith and Hildyard 1984). Larger, mobile mammalian species such as big game and predators would be displaced as the reservoir is filled. However, since the habitat lost is not crucial to the effected populations, displacement should not reduce their abundance.

Loss of the 1.8-acre stock pond and wetlands within the reservoir site and along the canal routes would reduce habitat for some mammalian species such as muskrat and raccoon, and would eliminate these areas as a source of drinking water for other mammals. Potential loss of 1.15 acres of wetlands along the Greybull River between the diversion and return flow points represents an insignificant amount of wetlands occurring along the Greybull River. Creation of additional wetlands associated with the presence of a large reservoir may offset this loss and the presence of the reservoir would provide an additional source of drinking water. Therefore, no significant impacts are anticipated to mammal populations as a result of this reduction in wetlands. Presence of the reservoir would improve habitats for some species of mammals such as raccoons and mink by providing a reliable water source and through formation of new habitat types, and may increase their populations.

The overall effect of the reservoir would be to modify the species composition and relative abundance of the mammalian community in the project area through reducing abundance of small, nonmobile upland terrestrial species, and increasing abundance of semi-aquatic species and those species that favor large expanses of free water.

Construction of the reservoir would provide a more dependable water supply. As a result, approximately 1,400 additional acres would be put into crop production, and lower value crops such as alfalfa and barley would be replaced with higher value crops such as sugar beets and dry beans. These practices may alter composition and relative abundance of the mammal communities in the affected areas by reducing populations of those species that prefer fallow land and crop types reduced in acreage following construction of the reservoir. These species are typically abundant in agricultural areas and impacts would be considered insignificant.

Blackstone Gulch Alternative

Total acres of rangeland habitat lost through construction and inundation at the Blackstone Gulch site would be approximately 730 acres, or 8 percent more than Lower Roach Gulch. It is assumed borrow areas for construction at this site would impact approximately the same acreage and vegetation types as at Lower Roach Gulch. Although construction of the reservoir at this site would have the same effects on mammals as at Lower Roach Gulch site, the relative impacts would be slightly greater due to the somewhat larger total area impac ed by disturbance and inundation.

Loss of the two stock ponds totaling 2.2 acres and wetlands within the reservoir site and return flow route would reduce habitat for some mammalian species such as muskrat and raccoon, and would eliminate these areas as a source of drinking water for other mammals. Potential loss of 1.46 acres of wetlands along the Greybull River between the diversion and return flow points represents an insignificant amount of wetlands occurring along the Greybull River. Creation of additional wetlands associated with the presence of a large reservoir may offset this loss and the presence of the reservoir would provide an additional source of drinking water. Therefore, no significant impacts to mammal populations as a result cf this reduction in wetlands is anticipated. Effects on mammals due to added irrigated acreage and change in cropping patterns would be the same as for Lower Roach Gulch.

No Action Alternative

The No Action Alternative is not expected to impact mammal populations in the project area. Species composition and relative abundance of mammals in the project area would remain as they currently are.

4.6.3.2 Birds

Lower Roach Gulch Alternative

Construction of the reservoir in Lower Roach Gulch would result in the loss of approximately 675 acres of upland habitats through construction of the dam and related facilities and inundation from the reservoir. An additional 1,025 acres would be lost at borrow areas. This loss would cause a decrease in the number of birds that occupy the habitat types affected.

This reduction would be permanent for the reservoir and dam area and temporary for borrow areas. The area impacted by the reservoir represents less than 1 percent of that habitat type available in the Greybull Valley, and this loss should not result in a significant impact to any avian population levels.

Loss of the 1.8-acre stock pond and wetlands within the reservoir site and along the canal routes would reduce habitat for some avian species such as waterfowl and shorebirds, and would eliminate these areas as a source of drinking water for other birds. Potential loss of 1.15 acres of wetlands along the Greybull River between the diversion and return flow points represents an insignificant amount of wetlands occurring along the Greybull River. Creation of additional wetlands associated with the presence of a large reservoir may offset this loss and the reservoir would provide an additional source of drinking water. Therefore, no significant impacts to avian populations as a result of this reduction in wetlands is anticipated.

Presence of the reservoir would provide habitat for numerous avian species not currently present in the project area. In India, the number of aquatic and semi-aquatic bird species observed after construction of a reservoir increased by 100 percent (Pandey 1993). Based on observations at Upper and Lower Sunshine reservoirs (WEST 1995a), nongame aquatic species expected to use the site following construction would include western grebe, eared grebe, pied-billed grebe, California gull, double-crested cormorant, common loon, white pelican, and killdeer as well as many other shorebirds and migrant waterfowl. As with mammals, the overall effect of the reservoir would be to decrease the number of terrestrial species and individuals, and increase the number of aquatic and semi-aquatic species and individuals in the project area.

The more dependable water supply associated with this alternative would result in irrigation of land currently not irrigated and a change in cropping patterns as discussed above. As with mammals, these changes would also modify species composition and relative abundance of avian communities in the affected areas.

Blackstone Gulch Alternative

Total acres of rangeland habitat lost through construction and inundation at the Blackstone Gulch site would be approximately 730 acres, or 8 percent more than at Lower Roach Gulch. It is assumed borrow areas for construction at this site would impact approximately the same acreage as at Lower Roach Gulch. Although construction of the reservoir at this site would have the same effects on birds as at Lower Roach Gulch site, relative impacts would be slightly greater due to the somewhat larger total area impacted by disturbance and inundation.

Loss of the two stock ponds totaling 2.2 acres and wetlands within the reservoir site and return flow route would reduce habitat for some avian species such as waterfowl and shorebirds, and would eliminate these areas as a source of drinking water for other birds. Potential loss of 1.46 acres of wetlands along the Greybull River between the diversion and

return flow points represents an insignificant amount of wetlands occurring along the Greybull River. Creation of additional wetlands associated with the presence of a large reservoir may offset this loss and the reservoir would provide an additional source of drinking water. No significant impacts to avian populations as a result of this reduction in wetlands is anticipated. Effects on birds due to added irrigated acreage and change in cropping patterns would be the same as for Lower Roach Gulch. Construction of the reservoir at this site would also provide habitat for aquatic and semi-aquatic birds described for Lower Roach Gulch.

No Action Alternative

Under the No Action Alternative, the avian community would remain as it currently is. No impacts to terrestrial birds would be expected. Habitat would not be created for aquatic birds in the project area, and avian species composition and relative abundance in the project area would remain as they currently are.

4.6.3.3 Reptiles and Amphibians

Lower Roach Gulch Alternative

Construction of the reservoir would result in loss of approximately 675 acres of rangeland habitats and an additional 1,025 acres at borrow areas. This loss would cause a decrease in the number of reptiles and amphibians that occupy the habitat types affected. Inundation of the reservoir would likely kill most reptiles and amphibians occupying the area. The area impacted by reservoir construction represents only a small fraction of that habitat type available in the Greybull River Valley, and this loss would not likely result in a significant impact to any populations. Loss of the 1.8-acre stock pond and wetlands within the reservoir site and along the canal routes would reduce habitat for amphibians in the project area. Potential loss of 1.15 acres of wetlands along the Greybull River between the diversion and return flow points represents an insignificant amount of wetlands occurring along the Greybull River. Creation of additional wetlands associated with the presence of a large reservoir may offset this loss. Therefore, no significant impacts to reptile and amphibian populations as a result of reduction in wetlands is anticipated.

Construction of the reservoir would provide a more dependable water supply. As a result, approximately 1,400 additional acres would be put into crop production, and lower value crops such as alfalfa and barley would be replaced with higher value crops such as sugar beets and dry beans. Conversion of fallow fields to irrigated crop may insignificantly reduce populations of most reptiles, especially lizards and snakes. However, the additional acreage under irrigation would likely provide more habitat for amphibians in the Greybull River Valley by creating additional wetlands.

Blackstone Gulch Alternative

Total acres of rangeland habitat lost through construction and inundation at the Blackstone Gulch site would be approximately 730 acres, or 8 percent more than at Lower Roach Gulch. It is assumed borrow areas for construction at this site would impact approximately the same acreage as at Lower Roach Gulch. Construction of the reservoir at this site would have the same effects on reptiles and amphibians as at Lower Roach Gulch site; however, the relative impacts would be slightly greater due to the somewhat larger total area impacted by disturbance and inundation. Loss of the two stock ponds totaling 2.2 acres and wetlands within the reservoir site and return flow route would reduce habitat for amphibians. Potential loss of 1.46 acres of wetlands along the Greybull River between the diversion and return flow points represents an insignificant amount of wetlands occurring along the Greybull River. Creation of additional wetlands associated with the presence of a large reservoir may offset this loss. Therefore, no significant impacts to amphibians and reptiles as a result of this reduction in wetlands is anticipated. Affects on reptiles and amphibians due to added irrigated acreage and change in cropping patterns would be the similar to Lower Roach Gulch.

No Action Alternative

The No Action Alternative is not expected to impact amphibian or reptile populations in the project area. Species composition and relative abundance of amphibians and reptiles in the project area would remain as they currently are.

4.6.4 AQUATIC RESOURCES

4.6.4.1 Fisheries

Direct and indirect impacts to the fish community in the Greybull River and other waters within the watershed were evaluated for the Lower Roach Gulch, Blackstone Gulch, and No Action Alternatives. Potential impacts are discussed in the following order: (1) the Wood River and upper Greybull River, (2) Upper Sunshine Reservoir, (3) the proposed diversion dam site, (4) the proposed reservoir site, (5) the discharge back to the Greybull River, (6) the Greybull River reach between the discharge and the Bench Canal, and (7) the Greybull River downstream of the Bench Canal.

Lower Roach Gulch Alternative

The upper Greybull and Wood rivers are diverted to supply water to Upper and Lower Sunshine reservoirs, which are part of the GVID water storage system. Zafft and Annear (1992) reported that cutthroat trout and mountain whitefish populations in the Wood and upper Greybull rivers presently are impacted due to these diversion practices. However, the diversion strategy to these reservoirs is not expected to change with addition of the Lower

Roach Gulch Reservoir to the system; therefore, no additional impacts to these fish populations are expected to occur.

The WGFD expressed concern that the recreational fishery in Upper Sunshine Reservoir may be impacted by severe water drawdown, if the proposed alternative is implemented. Upper Sunshine reservoir supports one of the most popular recreational trout fisheries in the region. However, the trout population does not reproduce in the reservoir; therefore, about 25,000 fingerling trout are stocked annually to sustain the fishery. Because the trout population is maintained entirely through stocking, potential impacts to trout reproduction are not expected. Potential impacts to trout in Upper Sunshine Reservoir addressed in this section are effects of the proposed alternative on trout survival and growth.

The WEST Team's OPSTUDY modeled predicted that storage in Upper Sunshine Reservoir would be significantly higher with addition of the Lower Roach Gulch Reservoir, even with increased demands on the system. In addition, the 5,000 acre-foot minimum pool would be invaded four fewer times with the Lower Roach Gulch Reservoir in the system than without it over the modeled period (WEST 1996b). Since the magnitude and duration of large draw downs in Upper Sunshine Reservoir are expected to be less with the Lower Roach Gulch Reservoir added to the system, and no changes are expected in WGFD stocking practices, no adverse impacts to trout survival and growth in the Upper Sunshine Reservoir trout fishery are expected. By adding the Lower Roach Gulch Reservoir to the system, predicted increases in annual storage and the reduced potential for exceeding a 5,000 acre-foot minimum pool in Upper Sunshine Reservoir may benefit the quality of the recreational trout fishery.

At the proposed diversion site, the Greybull River supports marginal, self-sustaining populations of cutthroat trout and mountain whitefish (Zafft and Annear 1992). Physical Habitat Simulation (PHABSIM) modeling conducted by the WGFD predicted that physical habitat for cutthroat trout and mountain whitefish presently is degraded in the Greybull River near the proposed diversion dam site because of increased late summer flows in the river caused by releases of water from the Sunshine reservoirs (Zafft and Annear 1992). The habitat modeling predicted that reductions in spring and summer flows due to diversions into the Lower Roach Gulch Reservoir would not benefit these fish populations near the diversion dam. Other factors, including low winter habitat abundance, high summer stream temperatures, and high ambient turbidity, limit the abundance of these species downstream of Meeteetse. The OPSTUDY model predicted that late summer flows would not be significantly different than existing flows; therefore, no additional impacts or benefits due to altered late summer flows are expected.

The primary potential impact to fisheries from the diversion dam would be blockage of fish passage and decreased river flow downstream of the diversion when the reservoir is being filled, primarily during the spring runoff period. To prevent adverse effects from decreased flows, the WGFD has recommended that no diversion occur when natural flow in the river is equal to or less than 50 cfs (Zafft and Annear 1992). OPSTUDY modeling that included

a 50 cfs bypass at the diversion dam predicted that flows in the Greybull River below the diversion dam would remain essentially unchanged if the Lower Roach Gulch Alternative is implemented. Therefore, the by-pass flow requirement should minimize impacts to the fish community downstream of the dam.

Fish passage within the Greybull River is interrupted by existing diversion structures. Lack of passage around diversion dams adversely affect fish populations, especially trout, by blocking movement to and from spawning areas. Construction of an additional diversion dam could increase the magnitude of this problem if fish passage is not provided; however, the proposed diversion dam is designed so the dam gates can be lowered during high flows to allow fish passage.

Some short-term impacts may occur during construction of the diversion dam. Construction of the diversion dam may increase sediment loading in the Greybull River. However, this impact should be minimized with the implementation of best management practices required as part of the Corps of Engineers 404 permit. If spills of fuel or other petroleum products occur during construction of the diversion dam, fish could be exposed to these substances. To minimize this risk, fueling and servicing of construction equipment should be done at sufficient distances from surface water and riparian areas to prevent spills from entering the water. It is expected that best management practices would be implemented during the construction phase to minimize this potential impact.

The WGFD would not establish or maintain a fishery in the Lower Roach Gulch Reservoir because of severe draw downs and predicted high turbidity in the reservoir. However, it is expected that a minimal fishery would develop naturally in the reservoir via the diversion canal. Survival of fish in the reservoir is expected to be low because of expected high turbidity and large fluctuations in reservoir levels.

The Lower Roach Reservoir would have a 2,500 acre-foot sediment storage space to trap sediments. Thus, releases of water from the reservoir are not expected to increase total dissolved solids (TDS) and total suspended sediment (TSS), or turbidity in the Greybull River; and no significant impacts to the fish community from these substances are expected. However, the WGFD expressed concern that water discharged back to the Greybull River from the reservoir may cause excessive erosion of the discharge canal and increase sediment loading in the river. Water would be conveyed via the natural drainage within the gulch. Extensive armoring (riprap) is proposed along this channel to prevent excessive erosion from increased flows. This construction design is expected to minimize erosion in the discharge canal and reduce potential sediment loading in the river.

The discharge of reservoir water often affects temperature, dissolved oxygen (DO), and nutrient levels in the receiving water body. Deep and relatively stable reservoirs develop thermal stratification resulting in decreased DO and increased nutrient levels in the hypolimnion. However, in the Lower Roach Gulch Reservoir, high rates of mixing during

reservoir fill, large draw downs, and short residence time for water in the reservoir should minimize thermal stratification, DO depletions, and accumulation of nutrients in the hypolimnion. Furthermore, reaeration should occur as the water flows over step structures in the discharge canal and the discharge outlet works should provide significant additional aeration of discharged water. Therefore, adverse effects from these three factors to the fish community in the Greybull River should be negligible.

From the reservoir discharge downstream to the Bench Canal, where most of the flow would be diverted, the OPSTUDY model predicted that with the Lower Roach Gulch Reservoir in the system, Greybull River flows would not increase significantly over current conditions. Because late summer flows are not expected to increase significantly in this section of the river, no adverse impacts are anticipated to the fish community. Likewise, flows are not expected to significantly increase in the lower-third of the river, where temperature and turbidity presently limit trout production (Zafft and Annear 1992). With approximately the same river flows, which affect both of these parameters, no change in temperature and turbidity are anticipated and no adverse impacts to trout populations in the lower Greybull River are anticipated.

Other fish species present in the river include longnose dace, flathead chub, fathead minnow, creek chub, plains killifish, white sucker, longnose sucker, and mountain sucker. Because many of these species inhabit a wide variety of waters with a wide range of substrates, flows, and turbidities in the Bighorn River Basin, and because the proposed project is not expected to affect these parameters, adverse impacts to these fish species are not expected.

Increased sediment loading to the Bighorn River as a result of construction and operation of the Lower Roach Gulch Reservoir should be negligible. From 1990 to 1992, suspended sediment concentrations in the Bighorn River (1990-1992) ranged from 38 mg/L to 6500 mg/L between Basin and Kane, Wyoming. With the Lower Roach Gulch Reservoir in the Greybull River system, sediment loading should not exceed this range and impacts to fish species and other aquatic organisms in the lower Bighorn River should be minimal.

In an attempt to reintroduce shovelnose sturgeon to the Bighorn River Basin, the WGFD stocked juvenile and fry into the Bighorn River system between Bighorn Reservoir Dam and Worland in 1996. Adult sturgeon migrate into smaller tributaries, such as the Greybull River, to spawn during the peak of spring runoff. If the reintroduction is successful, Annear and Braaten (1995) predicted that the density of spawning adult shovelnose sturgeon should be greatest in the mainstem Bighorn River because it is larger than the Greybull River and supports a greater area of spawning habitat. The OPSTUDY model predicted that with the Lower Roach Gulch Reservoir in the system, average peak spring flows at the mouth of the Greybull River would be reduced from approximately 673 cfs to 617 cfs, which should not affect shovelnose sturgeon spawning activities. Migration of shovelnose sturgeon up the Greybull River would not be affected by the Lower Roach Gulch diversion dam because

existing diversion dams, such as the Farmers Canal and Bench Canal diversions, currently prevent migration of shovelnose sturgeon to the diversion dam site.

Construction and operation of the Lower Roach Gulch Reservoir are not expected to increase sediment loading to the Bighorn River nor significantly reduce flows to the river over an annual period. Therefore, no negative impacts to Big Horn Lake or its fish community are expected to occur.

Blackstone Gulch Alternative

Effects to the fish community in the Greybull River and Upper Sunshine Reservoir are anticipated to be the same for this alternative as for the Lower Roach Gulch Alternative. The discharge return canal would be longer, which would provide a longer period for water discharged from the reservoir to equilibrate with ambient air temperature and to reaerate prior to discharge to the Greybull River. However, this difference is not expected to provide significant additional benefits to the fish community compared to the proposed alternative.

No Action Alternative

Under the No Action Alternative, there would be no change in river flows or water quality from present; therefore, no effects to the fish community would occur. The opportunity for increased storage in Upper Sunshine Reservoir and the reduced potential for exceeding the 5,000 acre-foot pool would be lost; therefore, potential benefits of these changes to the reservoir trout fishery would not occur.

4.6.4.2 Invertebrate Community

Lower Roach Gulch Alternative

Data on the benthic macroinvertebrate community in the lower Greybull River are limited. A kick net sample collected during fish surveys in 1995 contained three families of ephemeroptera, two families of tricoptera, 2 to 3 families of plecoptera, five or more families of dipterans, and at least one family of coleoptera. Annear and Braaten (1995) reported that macroinvertebrates in the lower Greybull River numbered from 100 to 250 organisms/ft^2. While these data are limited, they do fall within the range of macroinvertebrate taxa and densities reported by Pennak (1977) for 19 Rocky Mountain streams. Because flows and sediment loads in the Greybull River are not expected to increase or decrease significantly during construction or operation of the reservoir, significant reductions in aquatic macroinvertebrates and their habitats are not expected to occur.

Increased deposition of sediments upstream, and possibly downstream, of the diversion structure would likely occur. The proposed operational strategy of the diversion structure is to flush accumulated sediments periodically during high flows. Sediment deposition and

flushing at this site would affect the macroinvertebrate community. The length of river affected by this change in sedimentation would vary depending on the frequency of flushing but the effect on aquatic macroinvertebrates and their habitats should be minimal.

Blackstone Gulch Alternative

Effects to the benthic macroinvertebrate community in the Greybull River are anticipated to be the same for this alternative as for the Lower Roach Gulch Alternative.

No Action Alternative

Under the No Action Alternative, there would be no change in river flows or water quality from present; therefore, no effects to the benthic macro invertebrate community would occur.

4.6.5 SPECIES OF SPECIAL INTEREST

4.6.5.1 Raptors

Lower Roach Gulch Alternative

The only known recently active raptor nest at the Lower Roach Gulch Reservoir site is an American kestrel nest located in the reservoir site in 1995. This nest would be inundated if the reservoir is constructed. A prairie falcon nest, active in a cliff adjacent to the reservoir in 1990, is above the proposed high-water line and should not be affected; therefore, no impacts to prairie falcon nesting are anticipated. One of the golden eagle nests along the Greybull River between the diversion and the outflow is near the proposed diversion point, and disruption of golden eagle nesting may occur if construction occurs at the diversion point during the nesting period.

The reservoir would inundate approximately 675 acres of upland raptor foraging habitat. An additional 1,025 acres of upland foraging habitat would be lost at borrow areas. This habitat is abundant in the Greybull River Valley and this loss would not likely impact raptor populations in the Valley. New habitats created by the reservoir may offset this loss by providing other prey items such as fish, waterfowl, and shorebirds. These changes in prey composition and abundance may favor a different assemblage of raptors than what currently exists in the project area.

Blackstone Gulch Alternative

Construction of the reservoir at this alternative site would have the potential to impact two golden eagle nests. One nest is located along the Greybull River within 0.5 miles of the return flow route, and the other is located on a cliff face through which the tunnel would be drilled for the canal route to the reservoir. An American kestrel nest as well as two unoccupied nests

also are present on this cliff face. Drilling through this cliff face would likely displace these nesting birds if conducted during the nesting period and may dislodge the nests if significant ground vibrations occur from drilling or blasting.

The reservoir would inundate approximately 730 acres of upland raptor foraging habitat. It is assumed borrow areas for construction at this site would impact approximately the same acreage of upland habitat as Lower Roach Gulch and effects of this habitat loss would likely be similar. This habitat is abundant in the Greybull River Valley and this loss would not likely impact local raptor populations. New habitats created by the reservoir would have the same effects on raptors as at Lower Roach Gulch.

<u>No Action Alternative</u>

Under the No Action Alternative, no impacts to raptors are anticipated.

4.6.5.2 Waterfowl and waterfowl habitat

<u>Lower Roach Gulch Alternative</u>

The only habitat currently available for waterfowl in the area to be inundated at Lower Roach Gulch is a 1.8-acre stock pond. Inundation would result in the loss of this stock pond for breeding, resting, and foraging by waterfowl. Potential loss of 1.15 acres of wetlands along the Greybull River between the diversion and return flow points represents an insignificant amount of wetlands occurring along the Greybull River. Creation of additional wetlands associated with the presence of a large reservoir and increased irrigation in the valley may offset this loss. Therefore, no significant impacts to waterfowl populations as a result of wetland loss is anticipated.

The overall effect of the reservoir would likely be a dramatic increase in waterfowl in the project area, especially during migration. Construction of the reservoir would provide habitat for numerous species of waterfowl not currently present in the project area. Most use of a new reservoir would be by waterfowl staging during the migrating period. Based on observations at Upper and Lower Sunshine reservoirs (WEST 1995a), waterfowl species expected to use the site following construction would include common merganser, red-breasted merganser, bufflehead, Barrow's goldeneye, common goldeneye, lesser scaup, ring-necked duck, American widgeon, gadwall, mallard, green-winged teal, Canada goose, and American coot as well as several other species.

No conversion of native upland to cropland is expected as a result of the project (see Section 4.8.3 IRRIGATED AGRICULTURE); however, an increase in crop production in the valley associated with a more dependable water source could result in conversion of some fallow field waterfowl nesting habitat into cropland. Additionally, it is expected that some malt barley and alfalfa fields, foraging habitat for Canada geese and mallards, may be converted

to sugar beets and dry beans. This would result in the loss of some foraging habitat for these species. Despite the potential loss of some nesting and foraging habitat, the net increase in agriculture in the valley and the addition of a new reservoir is expected to increase waterfowl use of the valley.

Blackstone Gulch Alternative

The only habitat currently available for waterfowl in the area to be inundated at Blackstone Gulch are two stock ponds, one 1.6 acres and the other 0.6 acres in size. The 1.6-acre "Friday the 13th" reservoir is fenced and provides much better waterfowl nesting and foraging habitat than the stock pond located in Lower Roach Gulch. Inundation would result in the loss of these stock ponds for breeding, resting, and foraging by waterfowl. Potential loss of 1.46 acres of wetlands along the Greybull River between the diversion and return flow points represents an insignificant amount of wetlands occurring along the Greybull River. Creation of additional wetlands associated with the presence of a large reservoir and increased irrigation in the valley may offset some of this loss. Other effects on waterfowl of reservoir construction at this site would be similar to those described for Lower Roach Gulch.

No Action Alternative

Under the No Action Alternative, stock ponds on the reservoir sites would remain for use by waterfowl. A large reservoir staging area for migrating waterfowl would not be present in the project area.

4.6.5.3 Big Game

Lower Roach Gulch Alternative

No big game crucial winter range would be affected through construction of the reservoir at this site. Construction of the reservoir would inundate approximately 475 acres of pronghorn antelope winter/yearlong range and 200 acres of pronghorn antelope yearlong range. An additional 1,025 acres of yearlong range would be lost at borrow sites until these areas are successfully reclaimed. This loss represents 0.11 percent of the 701.2 square miles (640 acres equals 1 square mile) of winter/yearlong range and 0.11 percent of the 1,819.4 square miles of yearlong range available in the Fifteen Mile Pronghorn Antelope herd unit. The reservoir also would result in the loss of 1,700 acres of mule deer yearlong range, which comprises 0.41 percent of the 644.9 square miles of yearlong range available in the Greybull River Mule Deer herd unit. Approximately 139 acres of white-tailed deer yearlong range would be impacted, which comprise 0.02 percent of the 1,102 square miles of occupied yearlong range available in the Bighorn Basin White-tailed Deer herd unit. Due to the small fraction of available habitat lost or modified due to reservoir construction, and since the habitats are not crucial, reservoir construction at this site should have no measurable effect on big game carrying capacity or population size in the affected herd units.

Big game would temporarily be displaced from the immediate project area during the construction period. Because most construction would occur during summer, disturbance to wintering big game would be minimal. Following construction of the reservoir, additional traffic in the area may continue to temporarily displace some big game.

Based on big game distribution maps maintained by the WGFD, there are no known major migration routes which would be intersected by this alternative. However, areas where big game move to and from surrounding rangeland to the riparian area and agriculture fields may be intersected by canals and the reservoir site. The bottom of the canal to the reservoir would be 15 feet wide with a side slope of 2H:1V. The depth of flow would be 8.4 feet and water velocity would be approximately 3.7 feet per second (2.5 mph) (GEI 1994a). It is expected that a canal with these dimensions, slope and water velocity would not seriously impede big game movement.

Change in cropping patterns also may affect big game use of the Greybull River Valley. With more dependable water sources, relatively low-value alfalfa and barley crops may be converted to higher value sugar beet and dry bean crops. A reduction in alfalfa acreage may reduce the amount of forage available to big game along the Greybull River. However, alfalfa is used for forage primarily during late spring and summer, when forage is seldom a limiting factor for big game populations. Reduction in alfalfa may also reduce the number of big game damage claims and reduce the cost of these claims to the WGFD. If any of the 1,400 acres of increased crop production includes alfalfa, the potential for big game damage claims may increase. The location and size of these additional acreage are unknown at present.

Blackstone Gulch Alternative

No big game crucial winter range would be affected through construction of the reservoir at this site. Construction of the reservoir at Blackstone Gulch would inundate approximately 730 acres of pronghorn antelope yearlong range. It is assumed that construction of the reservoir at this site also would result in disturbance to 1,025 acres at borrow sites. These disturbances represent 0.15 percent of the 1,819.4 square miles of yearlong range available in the Fifteen Mile Pronghorn Antelope herd unit. The reservoir also would inundate approximately 730 acres of mule deer yearlong range, which together with the borrow area disturbance comprises 0.43 percent of the 644.9 square miles of yearlong range available in the Greybull River Mule Deer herd unit. Approximately 730 acres of white-tailed deer yearlong range would be inundated, which comprises 0.10 percent of the 1,102 square miles of occupied yearlong range available in the Bighorn Basin White-tailed Deer herd unit. Due to the small fraction of available habitat lost or modified due to reservoir construction, reservoir construction at this site should have no measurable effect on big game carrying capacity or population size in the affected herd units.

Based on big game distribution maps maintained by the WGFD, there are no known major migration routes which would be intersected by this alternative. However, areas where big

game move to and from surrounding rangeland to the riparian area and agriculture fields may be intersected by the open portion of canals and the reservoir site. Effects of the canals and changes in cropping patterns associated with construction of the reservoir at this site would be similar to those associated with construction of the reservoir at the Lower Roach Gulch site with the exception that much less open canal is included.

No Action Alternative

Under the No Action Alternative, no impacts to big game would be expected.

4.6.5.4 Upland Game Birds

Lower Roach Gulch Alternative

No sage grouse leks have been documented within 2 miles of the proposed reservoir site or proposed borrow areas. Because most sage grouse nest within 2 miles of a lek, nesting would not likely occur at these sites. Construction of the reservoir would result in the loss of approximately 675 acres of sage grouse brood rearing and winter habitat. This loss is not likely to impact sage grouse in the Greybull River Valley, as habitat in the area to be inundated is marginal (T. Stevens, BLM, pers. commun.) and this habitat type is abundant and is not a limiting factor in the Greybull River Valley. Disturbance in the borrow areas would result in loss of sage grouse habitat. Provided there is successful reclamation of the borrow areas this loss will be relatively short-term. The stock pond and wetlands within the area to be inundated and along the canal route would be eliminated following construction of the reservoir. These areas may be used by sage grouse as a source of drinking water; however, presence of a new reservoir and any associated wetlands would replace these sources of drinking water for sage grouse in the project area.

As previously described, a more dependable water supply associated with a new reservoir would likely modify the acreage in alfalfa production in the Greybull River Valley. Alfalfa fields provide prime foraging habitat for sage grouse and a reduction in this crop type may reduce sage grouse abundance and alter distribution of this species in the Greybull River Valley. However, sage grouse use of alfalfa fields is opportunistic and they do not generally inhabit agricultural fields. Reduction of alfalfa production in the valley is not expected to have a significant impact on sage grouse in adjacent sagebrush habitat.

Wild turkey, ring-necked pheasant, and grey partridge use of the project area would be confined primarily to the Greybull River floodplain which would not be significantly affected by project activities. Changes in cropping patterns may affect distribution of these species in the Greybull River Valley. Construction of the reservoir would result in some habitat loss to chukar and mourning dove, although habitat for these species is abundant in the Greybull River Valley and is not a limiting factor.

Blackstone Gulch Alternative

Sage grouse leks have been documented approximately 1.5 and 2.0 miles south of the proposed reservoir site. Therefore, nesting by sage grouse may occur at the Blackstone Gulch Alternative site. Construction of the reservoir at this site would result in the loss of approximately 730 acres of sage grouse nesting, brood rearing, and winter habitat. This loss is not likely to impact sage grouse in the Greybull River Valley, as habitat in the area to be inundated is marginal (T. Stevens, BLM, pers. commun.) and this habitat type is abundant and is not a limiting factor. Disturbance in borrow areas would result in additional disturbance to sage grouse habitat. Additional impacts to upland game birds associated with this site would be similar in nature to those associated with the Lower Roach Gulch site.

No Action Alternative

Under the No Action Alternative, game bird populations and distributions would remain as they currently are in the Greybull River Valley.

4.6.6 THREATENED, ENDANGERED, AND CANDIDATE SPECIES

4.6.6.1 Threatened and Endangered Species

Lower Roach Gulch Alternative

Prairie dogs colonies, the primary habitat for black-footed ferrets, have not been documented at the proposed reservoir site, borrow areas, or canal routes. Because no impacts to prairie dog towns would occur as a result of this project, there are no anticipated impacts to black-footed ferrets.

All sightings of bald eagles have been during the winter; however, there are no known winter concentration areas in the Greybull River Valley. Winter construction activity has the potential to displace foraging bald eagles. However, such displacement would not have a significant effect on wintering populations because alternative suitable habitat is available throughout the Greybull River Valley. Creation of the reservoir may improve habitat for bald eagles to the extent that the reservoir provides waterfowl or fish habitat, as these are primary sources of food for wintering eagles.

Peregrine falcons may occasionally migrate through the Greybull River Valley. Spring or fall construction activity may displace migrating peregrines to alternative adjacent habitat but should not have a significant effect on migrating peregrines. As with bald eagles, a new reservoir in the area could improve habitat for this species to the extent that it provides waterfowl and shorebird habitat, the primary prey of peregrines.

Blackstone Gulch Alternative

Potential impacts on threatened and endangered species are essentially the same as those for Lower Roach Gulch. Potential sources of borrow material have not been identified for this alternative; therefore the potential exists that prairie dogs could occur on borrow areas which would increase the possibility of impacting black-footed ferrets.

No Action Alternative

No significant impacts to threatened and endangered species are expected under the No Action Alternative. Under this alternative, however, the opportunity to possibly benefit bald eagles and peregrine falcons through creation of reservoir foraging habitat would be lost.

4.6.6.2 Candidate Species

Lower Roach Gulch Alternative

As stated in Chapter 3, under new USFWS policy the only candidate species potentially occurring in the area are the mountain plover and sturgeon chub. This DEIS also addresses those species considered Category 2 candidate species prior to the change in policy on July 19, 1995. Habitat in the project area is not suitable for mountain plovers and no impacts to this species are expected at this site. Based upon past collection records and present data, there is no conclusive evidence that the sturgeon chub was ever part of the Greybull River ichthyofauna. Assuming this to be true, construction and operation of either off-channel alternative would have no effect on this species.

The only suitable habitat in the Greybull River Valley for white-faced ibis and black tern is along the Greybull River. Although some wetland loss may occur along the river, the loss represents only a small fraction of those wetlands available along the river, and presence of a reservoir would provide additional wetlands and thus habitat for these species. Ferruginous hawks have been documented to breed in the project area, but nesting locations have not been confirmed. Inundation of the reservoir and disturbance at borrow areas would result in the loss of ferruginous hawk nesting and foraging habitat. These habitats in the Greybull River Valley are abundant and should not be a limiting factor for this species.

Loggerhead shrikes were observed in Lower Roach Gulch during the spring migration period, and were documented breeding within the area to be inundated during the summer of 1995. Inundation of the reservoir would eliminate future breeding by this species at this site. Loggerhead shrikes use a variety of shrubs and trees for breeding (Woods 1993), and these habitat types are abundant in the Greybull River Valley. Therefore, loss of Lower Roach Gulch as breeding habitat would not likely reduce populations of this species in the Greybull River Valley. Construction of the reservoir would result in some habitat loss for western burrowing owl and eastern short-horned lizard; however, these species were not documented

in the project area and no significant impacts are likely. No critical habitat for bats was documented in the project area. Most use of the project area by bats likely occurs along the Greybull River which will not be significantly impacted by project activities. Persistent sepal yellowcress was not documented in the project area during ground surveys and there is no record of its occurrence. Because habitat of this species is mudflats where water levels fluctuate, construction of the reservoir would provide habitat for this plant not currently available in the project area.

Blackstone Gulch Alternative

No critical habitat for candidate species was documented at this site, and effects on candidate species at this site would be similar to those at the Lower Roach Gulch Alternative.

No Action Alternative

The No Action Alternative is not expected to impact candidate species in the project area .

4.6.6.3 Species of Concern in Wyoming

Lower Roach Gulch Alternative

No critical habitat for species of concern was located in the project area. Yellow and black-billed cuckoos would be confined to the Greybull River riparian zone, which will not be significantly impacted by project activities. No habitat currently exists for common loon in the project area. Construction of the reservoir would provide habitat for this species during the migration periods. Appropriate habitat for small dropseed was searched, and this species was not located in the project area. Therefore, no impacts to this species are anticipated.

Blackstone Gulch Alternative

Effects on species of concern of constructing the reservoir at this site would be similar to those at the Lower Roach Gulch site.

No Action Alternative

No impacts to species of concern in Wyoming would be expected under this alternative.

4.7 LAND USE

4.7.1 CROPS AND CROPPING PATTERNS

Implementation of either of the two alternatives would be expected to result in similar changes in crops and cropping patterns. These potential effects are fully described for the action alternatives in Chapter 1. Implementation of the No Action Alternative would mean that there likely would be few changes in crops without changes in price, market, or other outside factors. It would be even more unlikely that acreage under actual cultivation could be expanded without supplemental water supplies.

4.7.2 CROP WATER REQUIREMENTS

Lower Roach Gulch Alternative

The proposed reservoir was sized to provide a firm yield of irrigation water to minimize shortages for current and anticipated future farming practices in the GVID. Modeling of the system hydrology by GVID using an OPSTUDY model (SWWRC 1995) indicated that annual system yield on the Greybull River would increase by approximately 27,400 acre-feet due to operation of the reservoir. Annual yield from Lower Roach Gulch Reservoir would be approximately 22,900 acre-feet per year and increased efficiency in operation of the upper valley reservoirs would increase yield from these reservoirs by about 4,500 acre-feet per year. These yields are less than those shown in GEI (1994a and 1994b) due to the addition of a minimum flow bypass of 50 cfs at the reservoir diversion.

Concurrent modeling was prepared by the WEST Team (WEST 1996b), using the same model and independently prepared estimates of current cropping patterns in the valley, actual irrigated acreage changes in cropping patterns due to construction of the reservoir, new information on conveyance losses (Lewallen 1994), and increases in irrigated acreage. Estimated future demands were based on results of the sales of shares rather than the irrigation survey. It was assumed that the maximum amount of land not currently irrigated that could be put into production was 1,400 acres based on the number of shares in the reservoir that had not yet been reserved. This maximum number was used to provide a conservatively high estimate of potential future demands. The purpose of the WEST Team's modeling was to provide a more realistic estimate of current shortages in the valley based on the irrigation survey conducted by GEI (1994a) and to determine if the proposed reservoir would provide an adequate supply for the increased acreage and change in cropping patterns desired by GVID members.

The hydrologic model indicated that the average annual shortage under present conditions is approximately 8,560 acre-feet per year. The 2-year (50 percent probability) shortage is approximately 1,840 acre-feet and the 5-year (20 percent probability) shortage is approximately 10,620 acre-feet. The 10-year (10 percent probability) shortage increases substantially to approximately 23,780 acre-feet. Finally, the model estimated that 41,000 acre-feet of supply would be required by GVID to meet 100 percent of the demand for irrigation water eight out of ten years.

These shortages are under-estimated due to modeling limitations. For instance, shortages that occur early in the irrigation season due to icing of the upper valley reservoir outlet channels cannot be accurately modeled in the OPSTUDY model because climatic data are not included in the model. Other voluntary shortages such as the individual farmer's choice to short lower value crops to conserve reservoir storage for higher value crops also cannot be easily modeled. Another factor that results in higher demands is the desire of irrigators to secure irrigation supplies for future drought periods that occur with relatively low frequency. It is expensive to plant high value crops and crop loss in 1 year can result in the loss of several years of profit. Actual demands for supplemental water are higher than the modeled shortages would indicate as evidenced by the number of storage shares that have been reserved by irrigators to date.

Addition of a lower valley reservoir to the system, even with a switch to a greater percentage of high value crops and additional lands put into production, results in a substantial decrease in estimated shortages. The OPSTUDY model of future conditions indicates that availability of additional storage would reduce the average shortage to approximately 3,580 acre-feet. The 2-year shortage would be reduced to approximately 140 acre-feet, the 5-year shortage would be reduced to approximately 3,360 acre-feet, and the 10-year shortage would be reduced to approximately 3,860 acre-feet. Shortages cannot be completely eliminated because of the severe multiple-year droughts that have historically occurred in the valley. Addition of a lower valley reservoir also has positive effects on reservoir storage in the upper valley reservoirs. More stored water could be held in reserve in the upper valley reservoirs for use in drought conditions.

Blackstone Gulch Alternative

Changes in cropping patterns and water demand and the resultant water shortages are anticipated to be the same as for the Lower Roach Gulch Alternative.

No Action Alternative

Existing shortages would not be met and any substantial changes in existing cropping patterns would not be anticipated.

4.7.3 LIVESTOCK GRAZING

Lower Roach Gulch Alternative

Construction of the reservoir would inundate approximately 800 acres of the Tatman Mountain Common Allotment resulting in loss of approximately 3.6 percent of the allotment's acreage and 2.1 percent (37 AUMs) of the allotment's AUMs. Inundation would also result in the loss of a 1.8-acre impoundment used to provide water for livestock. The presence of the reservoir would more than adequately compensate loss of the stock pond as a source of drinking water.

Under the BLM grazing regulations and final rule (BLM 1995) there are two options when there is a decrease in public land acreage available for livestock grazing within an allotment: (1) grazing permits or leases may be canceled or modified as appropriate to reflect the changed area of use; and (2) permitted use may be canceled in whole or in part. The permittee is given 2 years prior notification before their grazing permit or grazing preference is canceled or modified (BLM 1995). In addition, the permittee may request a new grazing allotment from the BLM. Currently, three different livestock operators use the Tatman Mountain Common Allotment. It is likely that the grazing permit which operates in the zone of the allotment with the reservoir would be modified to reflect the reduced acreage.

Blackstone Gulch Alternative

Construction of the reservoir in Blackstone Gulch would inundate approximately 300 acres of the Fernandez/Blu-Jay Allotment, and approximately 500 acres of the North Blackstone Allotment. This loss represents approximately 2.7 percent of the acreage and 1.3 percent (14 AUMs) of the AUMs within the Fernandez/Blu-Jay allotment. However, inundation of the reservoir at this site would result in loss of approximately 60.7 percent of the North Blackstone Allotment's acreage and 52.6 percent (90 AUMs) of the AUMs within this allotment. Reservoir construction also would inundate two stock ponds used to provide water for livestock. Presence of the reservoir would compensate for loss of these stock ponds.

As with the Lower Roach Gulch Alternative the grazing permits for these allotments would be modified by BLM to reflect the lost acreage.

No Action Alternative

Under this alternative, no impact to livestock grazing in the project areas would occur.

4.8 SOCIOECONOMICS

This section describes future socioeconomic conditions for the Lower Roach Gulch, Blackstone Gulch, and No Action Alternatives. The analysis focuses on socioeconomic issues identified as being potentially significant during scoping. The project area for assessing effects on socioeconomic resources is defined as Big Horn and Park counties.

4.8.1 POPULATION AND EMPLOYMENT

Lower Roach Gulch Alternative

Lower Roach Gulch Reservoir would be built over an approximately 2-year construction period, with construction crews active approximately 10 months each year. The total cost of the project is expected to be $43.2 million, of which approximately $9.0 million would be spent on construction

labor. An average of 115 construction workers would be employed during the first year of construction, and an average of 170 workers would be employed during the second year. Approximately 20 management, engineering, and administrative personnel would also be employed locally during construction, bringing total direct employment levels to 135 persons during the first year and 195 persons during the second (O'Grady 1995a).

Some indirect jobs also would be created in the local economy because of construction expenditures. The number of indirect jobs created during project construction was estimated using input-output multipliers for the Wyoming economy developed by the Bureau of Economic Analysis of the U.S. Department of Commerce (USDC 1992). Results of the multiplier analysis indicate that about 100 indirect jobs would be created during the first year of construction and 142 during the second. The employment effects of the Lower Roach Gulch Alternative are summarized in the first two columns of Table 4.5. Total employment increases associated with the project would be 235 in the first construction year and 332 in the second.

Table 4.5 Short-term population and employment effects of the two action alternatives.

	Lower Roach Gulch Reservoir		Blackstone Gulch Reservoir	
Category	Year 1	Year 2	Year 1	Year 2
Employment				
Construction	115	170	127	187
Administrative	20	20	22	22
Indirect	100	142	110	156
Total	235	332	259	365
Population				
Construction	130	143	143	157
Administrative	23	23	25	25
Indirect	107	151	118	166
Total	260	317	286	348

The population estimates in Table 4.5 are based upon assumptions about how many workers would be hired from the local labor pool and how many workers would move into the area in response to the new job opportunities. Experiences at other construction sites indicate that up to 60 percent of the construction work force may relocate temporarily to the project area during construction, and up to 40 percent of these relocating workers may bring family members with them to the project area. The average family size for the relocating workers bringing families members with them is expected to be 3.2 persons (Watts & Associates In prep.).

Administrative personnel and families associated with the project are expected to have the same demographic characteristics as the construction work force. The majority of indirect jobs would be filled by unemployed and underemployed residents of the area, but some of these jobs may be filled

by persons moving into the area in search of employment. For purposes of this analysis, it was assumed that one-third of all indirect jobs would be filled by persons moving into the area with an average household size of 3.2 persons.

The projected population impacts associated with the Lower Roach Gulch Alternative are given in Table 4.5. The projected population increase associated with the construction work force would be 130 persons during the first year and 143 persons during the second year of construction. Administrative personnel and families associated with construction would add another 23 persons to the population influx. Indirect workers moving into the area would add 107 and 151 persons in the first and second construction years, respectively. Total population effects during the construction period would be 270 persons during the first year and 317 persons during the second year. These figures represent slightly less than a 1 percent increase in the combined populations of Big Horn and Park counties in 1990. The temporary population influx would be distributed among communities surrounding the construction site on the basis of temporary housing availability, as discussed in Section 4.8.4.1.

Construction of the reservoir would affect long-term employment and population in the project area because agricultural output would increase. An estimated 35 new jobs are created in the Wyoming economy for each $1 million in additional agricultural output in the state (USDC 1992). Lower Roach Gulch Reservoir would increase irrigation water availability in the GVID by approximately 23,500 acre-feet annually, and agricultural output is expected to increase by $2.5 million annually as a result (GEI 1994a). This increase in agricultural production would result in an estimated 88 new jobs in the regional economy.

In 1990, there were approximately two persons in the project area for each job (WDAI 1994). Construction of the Lower Roach Gulch Reservoir would thus result in an estimated permanent population increase of approximately 176 persons. This figure represents a 0.5 percent increase in the combined population of Big Horn and Park counties, which was 33,703 in 1990 (Table 3.11). Most of the new jobs and associated population growth would affect larger communities surrounding the GVID that supply area farmers. These communities include Cody, Greybull, Lovell, and Powell.

<u>Blackstone Gulch Alternative</u>

The Blackstone Gulch Alternative would cost approximately 10 percent more than the Lower Roach Gulch Alternative and would require a 10 percent larger construction work force. Total employment effects associated with the Blackstone Gulch Alternative are expected to be 259 persons during the first year and 365 persons during the second year (Table 4.5). The total population increase associated with Blackstone Gulch would be 286 persons during the first year and 348 persons during the second year. These figures represent an approximate 1 percent increase in the combined populations of Big Horn and Park counties in 1990. The temporary population influx would be distributed among communities surrounding the construction site on the basis of temporary housing availability as discussed in Section 4.8.4.1.

The Blackstone Gulch Alternative would provide the same irrigation benefits as the Lower Roach Gulch Alternative. As a result, its long-term effects on population and employment would be the same as Lower Roach Gulch.

No Action Alternative

In the absence of reservoir construction, there would be no short-term increases of population and employment in the project area.

The No Action Alternative would result in no long-term increases in agricultural output in the area. As a result, there would be no long-term employment and population increases associated with agricultural production in the GVID. In the absence of a reservoir, employment and population in the project area would be expected to grow gradually as has been the case in recent years.

4.8.2 INCOME

Lower Roach Gulch Alternative

The Lower Roach Gulch Alternative would have a short-term stimulating effect on household income in the project area due to local expenditures during the 2-year construction period. The exact magnitude of this impact would depend upon the extent to which local contractors are awarded work on the project, an unknown variable. For purposes of this DEIS, it is assumed that $16 million of expenditures would be made locally during construction. The remainder would flow out of the local area in the form of engineering fees and payments for heavy equipment usage by nonlocal contractors. If local contractors are awarded a substantial portion of the earthmoving work associated with the project, the amount spent locally would be larger (O'Grady 1995a).

Local construction expenditures would have a positive effect on area income over the 2-year construction period. During the first construction season, approximately $5.6 million would be spent locally, resulting in an increase of $2.3 million in household income. Approximately $10.4 million would be spent locally during the second year of construction, resulting in a $4.4 million increase in local household income (USDC 1992). The latter figure represents an approximately 0.7 percent temporary increase in household income in the two-county project area, which was $603 million in 1992 (WDAI 1994).

The Lower Roach Gulch Alternative would have positive long-term effects upon household income in the project area as a result of increased agricultural production. Each acre-foot of irrigation water in the GVID is estimated to increase farm income by $36.43 (Table 3.13, GEI 1994a). An additional 23,500 acre-feet of irrigation water annually would increase farm income by $856,000. Total farm earnings in the two-county project area in 1992 were approximately $40.0 million (WDAI 1994). The Lower Roach Gulch Alternative would thus have the long-term effect of increasing farm income in the two-county project area by approximately 2.1 percent annually.

Farm income increases associated with this alternative would have indirect positive effects on nonfarm household income because farmers would increase their spending in the regional economy. Some of these spending increases would be for supplies and materials needed to produce and harvest more crops each year. Other spending increases would be in the form of consumption expenditures for items such as food, entertainment, and household purchases. These types of expenditures stimulate the regional economy and result in increased income for nonfarm households. According to the USDC (1992), the annual $856,000 increase in farm income attributable to this alternative would result in a $2.0 million annual increase in nonfarm household earnings (one component of income). Much of this increase would accrue to households in the project area, although some would accrue to households in other parts of the state.

Total long-term personal income increases attributable to the Lower Roach Gulch Alternative are estimated to be approximately $2.9 million annually. This figure represents 0.5 percent of all personal income in the project area in 1992 (WDAI 1994).

Blackstone Gulch Alternative

The Blackstone Gulch Alternative would involve construction expenditures that are approximately 10 percent higher than the Lower Roach Gulch Alternative. Approximately $6.2 million would be spent locally during the first year of construction and approximately $11.4 million during the second year. The corresponding temporary increases in local household income would be $2.5 million and $4.8 million, respectively. The latter figure represents a temporary increase of approximately 0.8 percent in household income in the two-county project area. The Blackstone Gulch Alternative would provide the same irrigation benefits as the Lower Roach Gulch Alternative, so its long-term effects on income in the project area would be similar.

No Action Alternative

In the absence of reservoir construction, there would be no short-term increases in area income because of local spending for construction materials and labor. In the absence of a reservoir, there would be no long-term income increases associated with increased agricultural production. Household income would continue to remain below statewide averages.

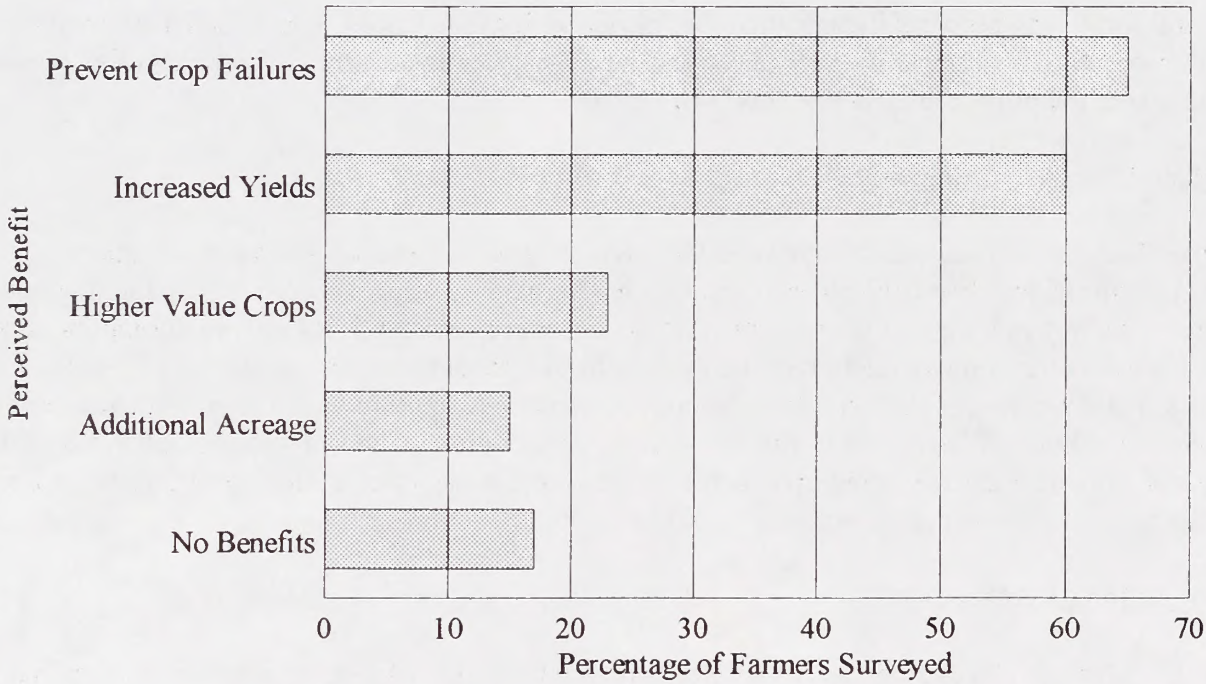
4.8.3 IRRIGATED AGRICULTURE

Lower Roach Gulch Alternative

Lower Roach Gulch is designed as an off-channel reservoir and its construction would not interfere with the operation of Upper or Lower Sunshine reservoirs or any existing diversions along the river. The reservoir site is not in irrigated crop production and only approximately 50 acres of borrow may be obtained from irrigated lands. Loss of such a small acreage is considered insignificant and there would be no short-term effects on irrigated crop production during the construction period.

The GVID irrigators were surveyed in 1991 to assess effects of the Lower Roach Gulch Alternative on irrigated agriculture in the project area (GEI 1994a). Results of that survey are depicted in Figure 4.3. According to survey respondents, the reservoir's most important effect would be to reduce the frequency of total crop failures that now occur in the district on a periodic basis (65 percent of respondents). Under current conditions, droughts severe enough to cause widespread crop failures occur at 10- to 15-year intervals at a high cost to irrigators because of the planting and growing costs that cannot be recovered (GEI 1994b).

Figure 4.3 Perceived benefits of additional irrigation water to GVID members (GEI 1994a).



Another important project effect would be to increase yields of crops currently grown in the area that do not reach full yield potential because of early- and late-season water shortages (60 percent of respondents). Under current conditions, snow and ice at Upper and Lower Sunshine reservoirs make it difficult to release irrigation water in the early spring immediately following planting. In the absence of sufficient natural precipitation during this period, crop yields could be adversely affected. Because of its lower elevation, Lower Roach Gulch would be able to deliver irrigation water when needed shortly after planting, which can occur as early as late February or early March (D. Edwards GVID, pers. commun.).

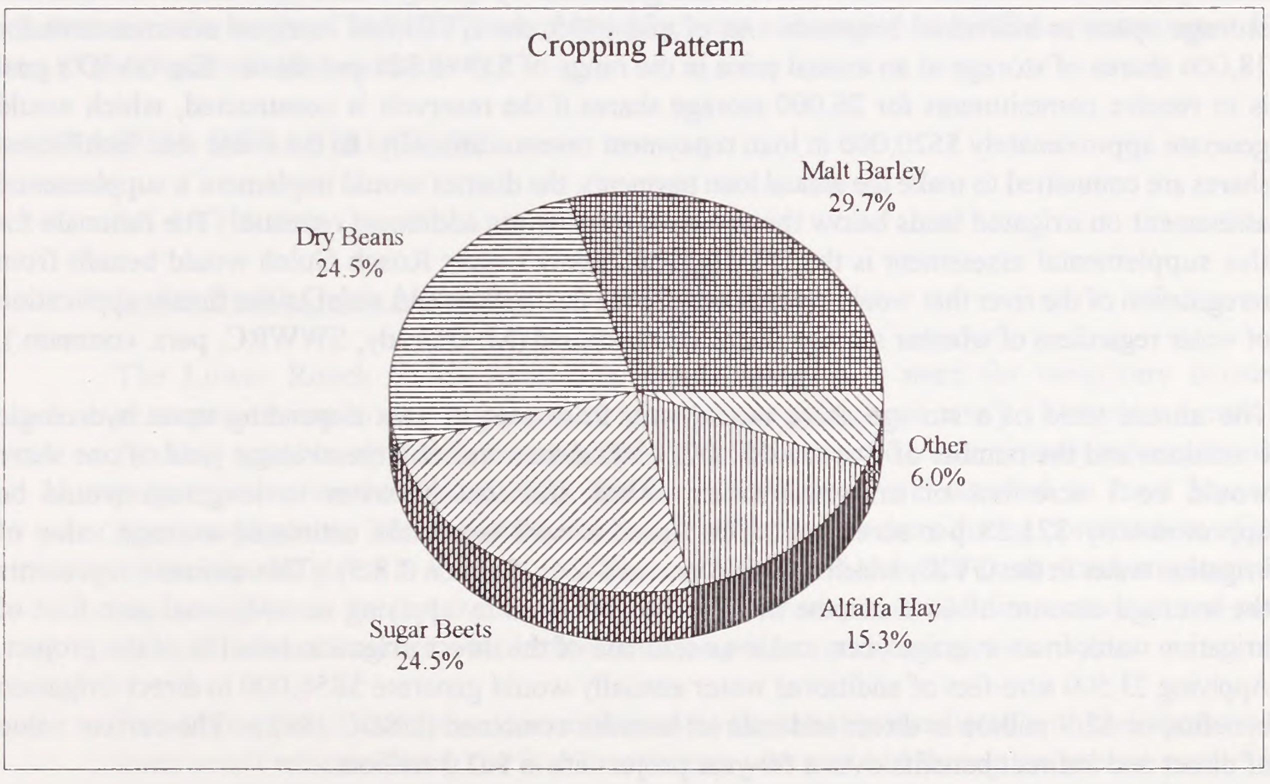
Lower Roach Gulch would also increase yields by supplying additional late season irrigation water and helping regulate the delivery of existing irrigation water supplies. Under existing conditions, early- and late-season water shortages result in average crop yields that are 10 to 20 percent below

full yield potential in most years (Edwards 1994). These yield reductions could be substantially reduced by the Lower Roach Gulch Alternative.

Lower Roach Gulch would also allow shorter response times to irrigator's calls for storage water releases because it is close to the diversion points for the Farmers and Bench canals, which serve approximately 50 percent of all irrigated land in the district. These lands are currently served by Upper and Lower Sunshine reservoirs, approximately 35 miles upstream.

A third effect of the Lower Roach Gulch Alternative would be to allow irrigators to plant a larger proportion of higher valued crops, such as sugar beets and dry beans (Figure 4.4). These crops may require more water than other crops and timely application of irrigation water is required to bring these crops to maturity. The Lower Roach Gulch Alternative would reduce uncertainty concerning irrigation water availability during the irrigation season, and thus provide an incentive to irrigators to plant a higher percentage of sugar beets and dry beans.

Figure 4.4 Estimated effects of the Lower Roach Gulch Alternative on irrigated agriculture in the project area based on responses of GVID irrigators in 1991.



Lower Roach Gulch would also allow some irrigators to plant more acreage, on the average, than they do under current conditions (15 percent of respondents). Approximately 88,000 acres of land

in the GVID have irrigation water rights, but only about 62,500 acres were irrigated in 1993 (GEI 1994a). Lower Roach Gulch is expected to increase this average to approximately 63,900 acres by supplying water on a reliable basis to about 1,400 acres of land that is currently irrigated only during wet years. No conversion of noncropland to cropland is expected as a result of the Lower Roach Gulch Alternative (O'Grady 1995b).

Another effect of the Lower Roach Gulch Alternative would be to increase cost of irrigation water. Under current conditions, GVID production costs per acre range from approximately $215 for malt barley to $546 for sugar beets (Table 3.14). These production costs would increase in varying amounts if the Lower Roach Gulch Alternative is constructed, depending upon the volume of irrigation water that individual irrigators contract for with the district.

The Lower Roach Gulch Alternative would be financed by the WWDC and costs would be partially paid for by assessments on GVID members. Financial plans include a WWDC grant for 75 percent of project costs, with the remaining 25 percent financed by a 50-year WWDC loan at 4 percent interest to be repaid by the district. If the construction cost is $43.2 million, the GVID would be responsible for annual loan payments of approximately $503,000 (GEI 1994b).

Loan payments would be made from revenue generated by selling 1 acre-foot shares of reservoir storage space to individual irrigators. As of mid-1995, the GVID had received commitments for 18,000 shares of storage at an annual price in the range of $19 to $21 per share. The GVID's goal is to receive commitments for 26,000 storage shares if the reservoir is constructed, which would generate approximately $520,000 in loan repayment revenue annually. In the event that insufficient shares are committed to make the annual loan payments, the district would implement a supplemental assessment on irrigated lands below the reservoir to generate additional revenue. The rationale for this supplemental assessment is that all irrigators below Lower Roach Gulch would benefit from reregulation of the river that would smooth out diurnal fluctuations and assist in the timely application of water regardless of whether storage shares are purchased (M. O'Grady, SWWRC, pers. commun.).

The annual yield of a storage share would vary from year to year depending upon hydrologic conditions and the number of shares sold. If 23,500 shares are sold, the average yield of one share would be 1 acre-foot of irrigation water. Thus, the cost of water to irrigators would be approximately $21.28 per acre-foot. This figure is well below the estimated average value of irrigation water in the GVID, which is $36.43 per acre-foot (Section 3.8.3). This estimate represents the average amount of farm income that can be generated by applying an additional acre-foot of irrigation water in an average year, and is an estimate of the direct irrigation benefits of the project. Applying 23,500 acre-feet of additional water annually would generate $856,000 in direct irrigation benefits, or $2.9 million in direct and indirect benefits combined (USDC 1992). The current value of direct and indirect benefits over a 50-year project life is $62.3 million.

Blackstone Gulch Alternative

The Blackstone Gulch Alternative also involves an off-channel reservoir. The reservoir site is not in irrigated crop production, and only approximately 50 acres of borrow may be obtained from irrigated lands. The loss of such a small acreage is considered insignificant and there would be no short-term effects on irrigated crop production during the construction period.

The Blackstone Gulch Alternative would provide the same irrigation benefits as the Lower Roach Gulch Alternative at a somewhat higher cost to irrigators and to the state of Wyoming for the same benefits. Blackstone Gulch's estimated construction cost is $47.6 million, meaning that the state grant (75 percent) to construct the project would be $35.7 million, a $3.3 million cost increase compared to Lower Roach Gulch. Annual payments by the GVID for Blackstone Gulch would be about $554,000, or $51,000 more than for Lower Roach Gulch. On a per acre-foot of yield basis, Blackstone Gulch irrigation water would cost $23.61.

No Action Alternative

Under the No Action Alternative, there would be no short-term effects on irrigated crop production. In the absence of supplemental irrigation water, GVID farmers would continue to experience yield reductions in the range of 10 to 20 percent annually, with widespread crop failures occurring at 10- to 15-year intervals (Edwards 1994).

4.8.4 LOCAL INFRASTRUCTURE

4.8.4.1 Housing

Lower Roach Gulch Alternative

The Lower Roach Gulch Alternative would result in a need for temporary housing accommodations during two construction seasons of approximately 10 months duration. Housing would be needed for those workers who are expected to temporarily relocate to the project area; workers hired from the local labor pool are assumed to have housing accommodations. The projected number of relocating workers during construction of the Alternative is given in Table 4.6. These projections are based upon total employment estimates given in Table 4.5 and the assumptions that 60 percent of direct workers and one-third of indirect workers would relocate to the project area during construction.

Based upon these assumptions, an estimated 81 households associated with the direct work force would relocate during the first construction year and 114 during the second year. The number of relocating indirect households would be 33 in the first year and 50 in the second (households include workers with and without families).

Table 4.6 Projected number of temporarily relocating workers during construction of the action alternatives.

Category	Lower Roach Gulch Reservoir Year 1	Lower Roach Gulch Reservoir Year 2	Blackstone Gulch Reservoir Year 1	Blackstone Gulch Reservoir Year 2
Direct workers				
Construction	69	102	76	112
Administrative	12	12	13	13
Subtotal	81	114	89	125
Indirect workers	33	50	36	55
Total	114	164	125	180

The closest incorporated communities to the construction site are Burlington (11 miles), Basin (29 miles), and Greybull (35 miles). During mid-1995, however, there was virtually no rental housing available in those communities. Some rental housing was available in Cody (43 miles) and Powell (45 miles), but that availability could change rapidly in response to the needs of community college students in Powell and seasonal workers associated with the tourism industry in Cody (H. Barnett, Hub Real Estate, pers. commun.). As a result, a sizeable portion of the work force that would temporarily relocate to the area for the construction period may not be able to secure rental housing accommodations.

Other housing options include motel rooms and developed campgrounds with recreational vehicle (RV) hookups. The project area includes 51 motels with over 1,600 rooms and 12 private campgrounds with over 300 full RV hookup sites. The area experiences heavy tourist traffic during summer months, however, and the price and availability of motel and campground accommodations may discourage workers from using them. Workers employed on road construction crews west of Cody during the summer of 1995 had difficulty finding affordable living accommodations (Laramie Daily Boomerang 1995).

Another option involves establishing a construction camp with temporary housing accommodations for workers at or near the construction site. While this option would alleviate the undersupply of affordable housing accommodations, it could also create environmental problems. Utilization of existing housing accommodations would be preferable from an environmental perspective if availability at an affordable price could be insured. One option would be for construction contractors to enter into lease arrangements with area motels and campgrounds to insure adequate accommodations for incoming workers, and subsidize rates if necessary to make them affordable during the peak tourist season. This option would have no negative environmental effects other than inconveniencing some tourists, who may have more difficulty reserving accommodations during peak travel months.

For purposes of this DEIS, it was assumed that contractors would be responsible for leasing adequate motel and campground space for incoming workers. Worker households were

assigned to communities based upon the assumption that accommodations closer to the construction site would be secured first, subject to the constraint that no more than 25 percent of available motel rooms and full RV hookup sites in any one community could be reserved for construction workers and associated administrative personnel.

The projected distribution of temporarily relocating workers and their families during peak construction (year 2) is given in Table 4.7. The majority of temporary workers are expected to reside in Greybull and Cody, with smaller numbers residing in Basin, Meeteetse, and Powell. Construction workers would be required to commute between 26 miles (Meeteetse) and 45 miles (Powell) each way on a daily basis.

Table 4.7 Projected distribution of temporarily relocating workers and family members during construction of the action alternatives - year 2

Community	Lower Roach Gulch Reservoir: Miles to Site	No. Direct workers	No. Indirect workers	Population Increase	Blackstone Gulch Reservoir: Miles to Site	No. Direct Workers	No. Indirect Workers	Population increase
Meeteetse	26	6	3	17	20	9	3	17
Basin	29	2	1	6	35	2	1	6
Greybull	35	40	18	110	41	40	17	110
Cody	43	59	258	163	40	66	30	192
Powell	45	7	3	21	51	8	4	23
Total		114	50	317		125	55	348

The Lower Roach Gulch Alternative would have the long-term effect of increasing population in the project area by an estimated 176 persons, or approximately 60 households. Most of this population increase would occur in larger communities surrounding the GVID that serve as supply centers for area farmers. The demand for additional permanent housing in these larger communities would serve as a stimulus to the construction industry in the area.

Blackstone Gulch Alternative

The Blackstone Gulch Alternative would require a 10 percent larger construction work force than the Lower Roach Gulch Alternative. As a result, there would be approximately 180 temporarily relocating workers in the project area during peak construction (Table 4.7).

Table 4.7 shows the projected distribution of temporarily relocating workers and family members during peak construction at the Blackstone Gulch site. Blackstone Gulch is expected to have the same population effect on Basin, Meeteetse, and Greybull as the Lower Roach Gulch Alternative because temporary housing is limited in these communities. This alternative would result in increased population effects in Cody and Powell as a result of

overflow from the smaller communities. The total temporary population increase associated with the Blackstone Gulch Alternative is 348 persons.

The Blackstone Gulch Alternative would result in the same long-term population effects as the Lower Roach Gulch Alternative. As a result, its long-term effects upon housing and in the construction industry in the construction area would be similar.

No Action Alternative

The No Action Alternative would not stimulate short-term increases in housing demand in the project area. The No Action Alternative would result in no long-term increases in agricultural output or associated population growth. As a result, there would be no long-term effects upon the housing sector attributable to irrigation.

4.8.4.2 Transportation

Lower Roach Gulch Alternative

Construction of the Lower Roach Gulch Alternative would result in increased traffic on area highways from trucks hauling construction materials and equipment to and from the site. Construction workers commuting to and from the job site would also add to traffic flows. Most traffic would likely access the construction site from U.S. Highway 14-16-20 north of Burlington, which provides the quickest access to Greybull and Cody. This highway is in good condition and built to modern safety standards. The increased traffic should not pose significant safety problems.

Traffic increases would also occur on State Highway 30, which provides access to the site from U.S. Highway 14-16-20, and along the paved county road from State Highway 30 to Meeteetse. These roads are narrow and could pose some safety problems during peak traffic periods at the beginning and end of construction shifts. The paved county road from the construction site to Meeteetse is in good repair but not designed to handle heavy equipment traffic that would be associated with dam construction (K. Frank, WYDOT, pers. commun.).

The Lower Roach Gulch Alternative would have the long-term effect of increasing agricultural production in the project area by approximately $2.5 million annually, and increasing the permanent population of the area by an estimated 176 persons. These changes would result in some minor increases in truck traffic associated with farm activity. They would also cause a minor increase in personal automobile traffic.

Blackstone Gulch Alternative

The Blackstone Gulch site is approximately 6 miles west of Lower Roach Gulch, south of the paved county road linking State Highway 30 and Meeteetse. Traffic flows and patterns

associated with this site should be similar to the Lower Roach Gulch site with one exception. Because the Blackstone Gulch site is further west, the driving distance to Cody from this site is shorter via Wyoming Highway 120 than via U.S. Highway 14-16-20. As a result, construction workers living in Cody would be more likely to use the paved county road linking Meeteetse with the site than would be the case with Lower Roach Gulch. The long-term effects of this alternative on transportation resources would be similar to Lower Roach Gulch.

No Action Alternative

The No Action Alternative would involve no construction activity and would thus leave traffic flows unaffected. The No Action Alternative would not affect either truck transportation associated with farming or personal automobile traffic.

4.8.4.3 Law Enforcement

Lower Roach Gulch Alternative

Construction of the reservoir would place increased demands upon law enforcement resources in rural areas of Big Horn and Park counties. Although the Park County Sheriff's Department is adequately staffed, the Big Horn County Sheriff's Department is stretched thin, with a service ratio of one officer for each 904 rural residents. The comparable ratio for Park County is one officer for each 588 residents (WDCI 1995).

Potential project effects with respect to law enforcement include safety problems associated with drinking and driving along roads leading to the construction site and bar fights in drinking establishments in surrounding communities (Watts 1994). Law enforcement capabilities in Basin, Greybull, Cody, and Powell, where most temporarily relocating construction workers are expected to live, are adequate. There may be a need for an additional Big Horn County Sheriff's Deputy to patrol rural traffic routes east of the construction site (D. Mattis, Big Horn County Sheriff, pers. commun.). The cost of an additional deputy is expected to be in the range of $25,000-30,000 annually. The prospects of county funding for an additional position are unknown at this time.

This alternative would result in a permanent population increase in the project area of an estimated 176 persons. This increase is only 0.5 percent of the combined populations of the two counties and thus should have only negligible effects on law enforcement resources.

Blackstone Gulch Alternative

Law enforcement effects would be somewhat larger for Blackstone Gulch than for the Lower Roach Gulch because the construction work force would be about 10 percent larger. The Blackstone Gulch Alternative would also shift some of the law enforcement burden from Big

Horn to Park County, because workers commuting from Cody would be more likely to access the construction site via Meeteetse, thus not traveling through Big Horn County on the way to and from work. The Blackstone Gulch Alternative would have the same long-term effects on population and law enforcement resources as the Lower Roach Gulch Alternative.

No Action Alternative

The No Action Alternative would have no short-term effects upon law enforcement resources in Big Horn or Park County. This alternative would have no-long term effects on law enforcement resources in the project area.

4.8.4.4 Health Care

Lower Roach Gulch Alternative

Construction of this alternative may place increased demands upon emergency medical care providers because of the potential for construction-related accidents. The Burlington Fire Department maintains an ambulance staffed by volunteers trained in emergency medical procedures. This team would provide the fastest response to the construction site and would transport accident victims to Cody, the closest hospital. The Cody hospital has adequate facilities and trained staff to handle most emergency situations. Some compensation for volunteer ambulance services may be expected from the construction contractor (D. Mattis, Big Horn County Sheriff, pers. commun.).

Blackstone Gulch Alternative

This alternative would place slightly higher short-term demands upon area health care resources because the construction work force would be 10 percent larger than for the Lower Roach Gulch

No Action Alternative

The No Action Alternative would have no short-term effects upon health care resources.

4.8.4.5 Public Schools

Lower Roach Gulch Alternative

Approximately 164 households would relocate to the project area during the peak construction period (Table 4.7). About 40 percent of the relocating construction and administrative workers (32 households) and all of the indirect workers (33 households) are expected to be families with the possibility of school-aged children. Based upon previous studies, the number of school-aged children per family is expected to be 0.9, meaning that

about 32 additional school-aged children would move into the project area during the peak construction year (Watts & Associates In prep.).

The distribution of school-aged children is expected to be the same as the distribution of the relocating population (Table 4.7). Based upon that distribution, the number of additional school-aged children that would be expected by community is: Basin 1; Greybull 11; Cody 18; Meeteetse 2; and Powell 2.

The addition of one and two students to school enrollments in Basin, Meeteetse, and Powell, would not have noticeable effects given the variation in enrollments due to other factors. Assuming an equal distribution among grade levels, enrollment increases in Greybull would average about 0.85 students per grade (K-12). The corresponding enrollment increase for Cody would be about 1.2 students per grade. These enrollment increases are expected to have only negligible effects on school resources because they would be spread over numerous school districts and grade levels for a relatively short period.

Blackstone Gulch Alternative

This alternative would require a construction work force approximately 10 percent larger .han the Lower Roach Gulch Alternative, and would also result in approximately 10 percent more school-aged children enrolling in area schools during project construction. This increase would mean that an additional three students, for a total of 35, would be enrolled in project area schools during the construction period. As with the Lower Roach Gulch Alternative, only negligible effects on educational resources would be expected because these students would be spread over numerous school districts and grade levels for a relatively short period.

4.8.5 PUBLIC REVENUES

Lower Roach Gulch Alternative

An estimated $16 million would be spent locally during construction of Lower Roach Gulch Reservoir; this estimate includes approximately $9 million in construction payroll and $7 million in locally purchased materials. All of the $7 million of materials purchases would be subject to local sales and use taxes, currently 4 percent in Park County and 5 percent in Big Horn County (P. McColl, Park County Treasurer's Office; E. Edwards, Big Horn County Treasurer's Office, pers. commun.).

The $9 million in local payroll would be divided among expenditures for taxable items, expenditures for nontaxable items, and savings (deferred consumption). Approximately 40 percent of all local payroll would be spent for taxable items, meaning that $10.6 million in local expenditures would be subject to local sales and use taxes (USDC 1993a). If these expenditures are divided equally between Park and Big Horn counties, the temporary increase in sales and use tax revenues would be $212,000 for Park County and $265,000 for Big Horn County.

On an average annual basis, sales tax revenues in the two-county area would increase approximately 1.5 percent each year during the 2-year construction period for the Lower Roach Gulch Alternative. These revenues would be shared between county governments and incorporated municipalities based upon population ratios established by the state of Wyoming.

The Lower Roach Gulch Alternative would involve acquisition of approximately 355 acres of private land by the GVID. Approximately 300 acres of this land are rangeland, and the remainder is irrigated land along the supply canal. Because irrigation district property is not taxable under Wyoming statutes, this acquisition would result in a small decrease in property tax revenues in Park County. The total assessed value of the land that would be taken off the tax rolls would be $3,350. At current tax rates, the annual revenue loss for Park County would be $240.66 (P. Meyer, Park County Deputy Assessor, pers. commun.). The right-of-way access to the reservoir site would not affect federal payments in lieu of tax revenues to local governments.

Lower Roach Gulch would have a positive long-term effect upon sales and use tax revenues in the project area, because of the population and employment increases brought about through increased agricultural production. Long-term annual earnings increase in the project area due to the reservoir is estimated to be $2.0 million. If 40 percent of that amount is spent locally on sales of taxable items, the average annual increase in sales tax revenues would be approximately $16,000 for Park County and $20,000 for Big Horn County. These estimates represent an approximately 0.2 percent increase in annual sales and use tax revenues for the two counties combined.

<u>Blackstone Gulch Alternative</u>

The Blackstone Gulch Alternative is estimated to cost approximately 10 percent more than the Lower Roach Gulch Alternative, and local expenditures on sales taxable items would be approximately 10 percent higher. Over the 2-year construction period, sales tax revenues to Park County from this alternative would total approximately $233,000. The corresponding figure for Big Horn County is $291,500. Blackstone Gulch construction would cause a 1.6 percent annual increase in sales tax revenues in the project area over the 2-year construction period.

The Blackstone Gulch site is located on BLM-administered land, with the exception of lands near the Greybull River diversion and the beginning of the supply canal and tunnel. Approximately 50 acres of private irrigated land around the diversion works and canal would be acquired by the GVID and removed from Park County tax rolls. This land has an assessed valuation of approximately $2,500, and at current tax rates, annual revenue loss for Park County would be approximately $180.00 (P. Meyer, Park County Deputy Assessor, pers. commun.). The right-of-way access to the reservoir site would not affect federal payments in lieu of tax revenues to local governments.

No Action Alternative

The No Action Alternative would have no effect upon current project area sales and use tax revenues of approximately $16.3 million annually. The No Action Alternative would have no effect upon current levels of public revenue in the project area.

4.8.6 LANDOWNERSHIP AND USE

Lower Roach Gulch Alternative

There would be short-term land use effects associated with construction activity in and around the reservoir site. Several hundred acres of rangeland and possibly 55 acres of irrigated lands would be disturbed for borrow materials and activities associated with dam construction. With the exception of the 55 acres of irrigated lands, potential borrow areas are south of the reservoir on BLM administered land. Some construction activity would take place on privately owned land which would be acquired by the GVID prior to the start of construction.

The dam site and portions of the supply canal route are located on private land that would be purchased by the GVID. Approximately 300 acres of rangeland and 55 acres of irrigated land would pass into GVID ownership. A small amount of this land may continue to be used for grazing after construction (M. O'Grady, SWWRC, pers. commun.).

Blackstone Gulch Alternative

The Blackstone Gulch Reservoir site and borrow areas are located entirely upon BLM-administered land. Several hundred acres of rangeland would be disturbed by borrow activity and reservoir construction as would about 50 acres of irrigated land near the diversion dam and supply canal.

Approximately 50 acres of private land would be acquired by the GVID if Blackstone were constructed. This land is currently irrigated and lies along the south side of the Greybull River near the site of the proposed diversion dam. This land would go out of irrigation if the reservoir were built (M. O'Grady, SWWRC, pers. commun.).

No Action Alternative

The No Action Alternative would not affect current land use and ownership in the project area.

4.9 CULTURAL AND PALEONTOLOGICAL RESOURCES

Construction impacts to cultural resources in almost all cases completely destroy the cultural resources. This is especially true of borrow area construction where subsurface excavation of materials completely removes the cultural resources. Inundation generally destroys cultural resources

by the ebb and flow of the reservoir pool (wave action), and water churning within the reservoir. This will be especially true for the sites in this proposed reservoir because these cultural sites are contained in relatively shallow sediments, from the surface to not much more than 1 meter deep.

Significance of cultural resources is determined by addressing the four criteria for assessing the significance of historic properties set forth in the 1966 National Historic Preservation Act. These criteria are: the quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and: (a) that are associated with events that have made a significant contribution to the broad patterns of our history; or (b) that are associated with the lives of persons significant in our past; or (c) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or (d) that have yielded, or have the potential to yield, important information in prehistory or history. For the sites recorded as part of the Greybull Valley Dam and Reservoir project, it is criterion "d" that is primarily used.

Once the regulatory agencies have determined that they are in agreement with recommendations of "not eligible" for any given cultural site, there is then no effect, and no additional action on these cultural sites need be taken. For sites recommended for evaluative test excavation (that is, those sites with sufficient deposition to warrant testing to determine the nature and extent of subsurface cultural remains), testing will show that there are either the presence of significant buried remains or there are no intact, buried, scientifically valuable cultural resources. In the former case, mitigative measures would be developed to "salvage" the intact, buried cultural remains. In the later case, the site becomes "not eligible" and consequently there would be no effect. Once the mitigation phase is completed and approval is given by the regulatory authority, construction of the project may proceed.

Indirect effects would not be an issue for noneligible sites, or for sites having been mitigated. Indirect effects to cultural sites outside project areas could be in the form of increased access for unscientific collection and artifact removal, and possibly increased surface erosion of sediments on cultural sites due to recreational visitor activity.

<u>Lower Roach Gulch Alternative</u>

Fiftenn previously unrecorded cultural sites and two previously recorded cultural sites were found in the areas surveyed for the reservoir pool and borrow areas adjacent to the reservoir pool in 1995 and 1996. Of these sites, two are considered eligible for nomination to the National Register of Historic Places and one site is considered unevaluated pending evaluative test excavation.

There is a strong possibility of significant fossil deposits within the Willwood Formation in Lower Roach Gulch. Inundation by the reservoir and construction of the dam, delivery canal, diversion dam, return flow canal, public access and parking area, and associated project features including borrow

and construction areas have the potential to impact paleontological resources where these features encounter the Willwood Formation.

Blackstone Gulch Alternative

Seven previously unrecorded cultural sites were found in the areas surveyed for the Blackstone Gulch Alternative in 1995 and 1996. All of these sites are considered "not eligible" for nomination to the National Register of Historic Places. Thus, for the Blackstone Gulch Alternative there would be no effect to cultural resources.

The Blackstone Gulch project area likely has paleontological resources similar in quality and quantity to Lower Roach Gulch. However, since the delivery tunnel would be constructed through the Willwood Formation the potential for effecting paleontological resources under this alternative would be greater than under the Lower Roach Gulch Alternative.

No Action Alternative

No new impacts to cultural or paleontological resources are expected to occur under this alternative.

4.10 RECREATIONAL RESOURCES

4.10.1 FISHING

Lower Roach Gulch Alternative

Construction of the Lower Roach Gulch Alternative would not have major effects on area fisheries. The reservoir would not support a recreational fishery because of extreme pool fluctuations, and the WGFD would not attempt to manage it for that purpose (T. Annear, WGFD, pers. commun.). Although public access to the reservoir would be provided, minimal recreational facilities (access road and parking area) are anticipated and no fish stocking would occur; however, a marginal fishery may establish itself in the reservoir by fish moving through the delivery canal.

The GVID and the WGFD have negotiated an agreement to insure that additional water depletions in the Greybull watershed would not adversely affect existing fisheries (GVID 1996). One provision of that agreement would guarantee permanent public access to Upper Sunshine Reservoir if the Greybull Dam and Reservoir project proceeds to construction and operation. Although the GVID has long allowed public access to this fishery, the access has been at the discretion of the district. Future access would not be subject to revocation without the consent of the WGFD.

The agreement also includes provisions for a 5,000 acre-feet minimum pool at Upper Sunshine Reservoir that would be considered storage of last resort by the irrigation district. The GVID could invade the minimum pool if the water is needed for irrigation or if dam repairs are necessary, but

would be required to pay $5,000 into a fisheries enhancement fund managed by the WWDC for each invasion. That fund, including an initial $15,000 contribution by the GVID, would be used for restocking or other fisheries enhancement measures at the discretion of the WGFD. Other provisions of the agreement call for a 50 cfs minimum bypass at the diversion dam, and an agreement that the GVID would not modify its existing minimum bypass flows on the Wood and upper Greybull rivers.

Hydrologic modeling of Upper Sunshine reservoir by the WEST Team suggests that reservoir levels would be higher, on average, with the Lower Roach Gulch Reservoir in place than would otherwise be the case. The Lower Roach Gulch Alternative would also result in fewer invasions of a 5,000 acre-feet minimum pool for fisheries than would be the case for the No Action Alternative. Over the 45-year period (1945 through 1989), Upper Sunshine storage levels fell below 5,000 acre-feet in 7 years corresponding to three drought periods. The WEST hydrologic model estimates that had the Lower Roach Gulch Reservoir been in place during this period, there would have been minimum pool invasions in only 3 years corresponding to two drought periods.

The Lower Roach Gulch Alternative would thus result in guaranteed public access at Upper Sunshine Reservoir, funds for restocking the reservoir if the minimum pool is invaded, and more storage in the reservoir. These changes should enhance recreational sport fishing opportunities in the area

The Lower Roach Gulch Alternative would not adversely affect recreational fishing in the Greybull River because the river downstream of the diversion point is highly degraded and located on private land with limited public access. The 50 cfs minimum bypass at the diversion point is intended to support mountain whitefish, cutthroat trout, nongame fishes, and to preserve riparian habitat.

Blackstone Gulch Alternative

The Blackstone Gulch Alternative would have similar effects on recreational fisheries as Lower Roach Gulch. The Blackstone Gulch Reservoir would not support a recreational fishery because of extreme pool fluctuations, and the WGFD would not attempt to manage it for that purpose, although a marginal fishery may establish itself in the reservoir via the delivery canal and tunnel (T. Annear, WGFD, pers. commun.). The reservoir's effects on the Upper Sunshine trout fishery would be the same as the Lower Roach Gulch assuming that the same operational agreements were applicable.

No Action Alternative

The No Action Alternative would leave Upper Sunshine Reservoir as the most popular recreational fishery in the Greybull watershed. On an annual average basis, there would be somewhat less water in the reservoir than would be the case with either the Lower Roach Gulch or Blackstone Gulch alternatives. Furthermore, the reservoir would be more susceptible to severe drawdowns during drought periods than would be the case with either of the action alternatives

The No Action Alternative would not provide guaranteed public access at Upper Sunshine, and no fund would be established to restock and otherwise enhance the fishery. As a result, overall angler activity and fisheries benefits may be somewhat lower under this alternative than the others.

4.10.2 HUNTING

Lower Roach Gulch Alternative

The Lower Roach Gulch site contains no critical winter range for big game animals and would not intersect known migration routes. As a result, this alternative should have no measurable effects on big game populations or hunter success ratios in the Greybull watershed. Public access would be provided to about 300 acres of private rangeland being acquired by GVID at the reservoir site, resulting in a small increase in public hunting opportunities for deer and pronghorn antelope.

The reservoir would provide habitat for geese and ducks during migration, and thus would result in increased hunting opportunities for these species in and around the reservoir. The increased crop production that would occur if the reservoir were built might provide additional foraging habitat for these species. Shifts in cropping patterns would have negligible effects on waterfowl. Overall effects with respect to waterfowl hunting would be positive.

The reservoir site contains some marginal habitat for sage grouse, chukar and mourning dove, but this habitat type is abundant and not a limiting factor for upland game populations in the Greybull River Valley (T. Stevens, BLM, pers. commun.). As a result, there would be no effects on upland bird populations, although public access at the reservoir site would provide a small increase in hunting opportunities. Changes in cropping patterns in irrigated areas of the GVID may also effect the distributions of upland game birds in these areas, which lie on private land with limited public access.

Blackstone Gulch Alternative

No critical winter range for big game would be inundated by the Blackstone Gulch Reservoir, and it does not intersect any major migration routes. As a result, the Blackstone Gulch Alternative should have no measurable effects on big game populations or hunter success ratios. Because the reservoir site would be located entirely on public lands, there would be no increase in hunting opportunities for deer and pronghorn antelope compared to the Lower Roach Gulch Alternative.

The Blackstone Gulch Alternative would attract migrating waterfowl in a manner similar to the Lower Roach Gulch Alternative, and the contours of lands around the proposed shoreline are less steep and more conducive to hunting than at Lower Roach Gulch. Therefore, this alternative should result in increased waterfowl hunting activity compared to the Lower Roach Gulch Alternative. Like the Lower Roach Gulch Alternative, the reservoir should not affect upland game bird populations or hunter success ratios.

No Action Alternative

Under the No Action Alternative, no effects on big game, waterfowl, or upland bird hunting would be expected.

4.10.3 NONCONSUMPTIVE RECREATION

Lower Roach Gulch Alternative

Although the Lower Roach Gulch Reservoir would not be managed as a fishery, public access to the reservoir would be guaranteed as a condition of funding assistance by the Wyoming Water Development Commission (M. O'Grady, SWWRC, pers. commun.). The creation of a new reservoir with public access should result in an increase in nonconsumptive recreational activity in the area.

The types of recreational activity that would take place at the reservoir site cannot be projected with great certainty, but some insights can be gained from recreational use statistics for Wyoming state parks. Visitor participation rates for nonconsumptive recreational activities at Wyoming's 12 state parks, the majority of which offer some form of water-based recreational activity, show that relaxing, sightseeing, and picnicking are the most popular activities at such areas, followed by swimming, hiking, and boating (Table 4.8). Nature study and water skiing are also popular activities. Most of these activities would be available at the reservoir site.

Table 4.8 Visitor participation in nonconsumptive recreation at Wyoming state parks (WRC 1988).

Activity	Percentage of Visitors Participating
Relaxing	69.3
Sightseeing	60.5
Picnicking	51.1
Swimming	42.1
Hiking	26.4
Boating	21.8
Nature study	20.4
Waterskiing	18.5
Other	11.5

The amount of nonconsumptive recreational activity that the new reservoir would generate is partially a function of the timing that would be involved in filling and drawing down the reservoir during the irrigation and recreation season and partially a function of the recreational facilities developed at the

site. Hydrologic models of the reservoir's operations indicate that it would be subject to extreme fluctuations in water levels during the recreation season from June through September. On average, the reservoir would provide about 400 surface acres of water during June, but this figure would drop to fewer than 80 acres by the end of September. Water levels would drop by up to 100 feet during this period.

The extreme fluctuations in water levels and the steep and unstable shoreline of the reservoir would make access for water-based sports difficult. As a result there are no plans to develop extensive recreational facilities at the site. An access road and parking area may be the extent of facilities development. Although access would be limited for water-based activities, the site would provide some opportunities for hiking, sightseeing, picnicking, and relaxing. The access road to the site may also be used by mountain bikers.

Because the range of available recreational activities and facilities at the site would be limited, usage rates at other, more developed sites in the area provide an upper limit on the amount of use that would be expected at the Lower Roach Gulch Reservoir. In 1988, Boysen State Park in the southern Bighorn Basin experienced an estimated 11 nonfishing recreational activity days per surface acre (WRC 1988). Applying this ratio to the average summer water surface acreage of the Lower Roach Gulch Alternative of 275 acres results in an estimated annual usage of 3,025 activity days for this alternative. This figure represents almost 10 percent of all nonconsumptive recreational activity in the Grass Creek Planning Area as of 1990 (Table 3.19), but is unlikely to occur in the absence of recreational facilities at the site and given the extreme fluctuations in reservoir water levels that would occur during the recreation season.

Even if such levels of activity were to occur, there would be only minor changes in economic activity in the area because most of the recreationists are expected to be local residents. The reservoir's relatively remote location would discourage use by tourists, as would the lack of a viable fishery. Use of the reservoir by local residents would not change income levels in the area by a significant amount.

With an increase in public use of the reservoir there would be an increase in human use impacts such as litter, off-road vehicle use, and vandalism. Public lands to the south of the reservoir would also experience increased impacts such as new trails and two-tracks. There may be some increase in trespassing in the area surrounding the reservoir, which contains a mixture of public and private lands.

<u>Blackstone Gulch Alternative</u>

The effects of the Blackstone Gulch Alternative on nonconsumptive recreational opportunities would be similar to the Lower Roach Gulch Alternative, with one exception. The somewhat more stable and less steep shoreline may offer some opportunities for recreational boating that would not be available at the Lower Roach Gulch. As a result, overall nonconsumptive recreational activity with this alternative should be somewhat higher than with the Lower Roach Gulch Alternative.

No Action Alternative

The No Action Alternative would provide no additional opportunities for nonconsumptive recreation in the study area and no associated impacts.

4.11 VISUAL/AESTHETICS

Under the BLM VRM classification the area for both action alternatives falls into classes III and IV. Under class III, changes to the landscape are permitted and may attract attention, however, they should not dominate the view of the casual observer. Under class IV, changes are permitted and may be major; the level of change to the landscape may be high. For both of the action alternatives, the presence of a dam at the mouth of the gulch would be somewhat visible from County Road 91/138 which is located north of the sites (see Figure 1.1). Appendix C displays several pictures of each alternative taken from the proximity of the county road and depicting the presence of a dam at the mouth of the gulch. In neither case would the VRM class change because of the presence of the dam. Impacts to the visual environment are considered insignificant. Under the no action alternative there would be no change to the existing visual environment.

4.12 HAZARDOUS MATERIAL

Lower Roach Gulch Alternative

Hazardous materials that would be brought on-site during project construction and implementation include fuels, lubricants, coolants, and solvents necessary for the heavy machinery and transportation vehicle operation (Table 4.9). Fuels used would include gasoline and diesel fuel for powering vehicles, combustion engines, and heavy machinery, and natural gas for generating heat. Lubricants would include motor oil, transmission fluids, brake fluids, and miscellaneous lubricants and grease required by machinery and vehicles utilized in construction. Coolants (antifreeze) would be used in combustion engines used for construction, drilling, and transportation. Solvents include various cleaning solutions and paint thinner and would be used for general maintenance of construction equipment and operations facilities. Fuels, lubricants, coolants, and solvents all contain constituents deemed hazardous (EPA 1986b).

Additional hazardous materials that may be brought on site for project construction and operation include herbicides, paints, and explosives. Herbicides and paints would be used for maintaining the dam and reservoir operations facilities. Explosives may be used in the construction of the dam and delivery canal. Impacts from hazardous materials brought on-site are expected to be minimal provided proper use and handling guidelines are followed, personnel are trained in the correct use of the hazardous material, and State and Federal guidelines regarding hazardous material are followed.

Project implementation is expected to increase and alter agriculture production in the Greybull River Valley. There would be an associated increase in use of hazardous materials for agricultural

production such as pesticides, herbicides, fuels, lubricants, coolants, and miscellaneous hazardous materials such as solvents and paints. With this increase the potential for spills or misuse of the materials would be greater.

Table 4.9 Hazardous materials potentially used during the construction of Lower Roach Gulch or Blackstone Gulch alternative (V. Anderson, SWWRC, pers. commun.)

Hazardous Material	Estimated Quantity Likely Used for Construction
Fuels	
Gasoline	75,000 gals
Diesel	700,000 gals
Natural gas (propane)	100,000 ft^3
Lubricants	
Motor oil	2,500 gals
Transmission fluid	2,500 gals
Brake fluid	2,250 gals
Grease and miscellaneous lubricants	250 gals
Coolants	100 gals
Solvents	100 gals
Miscellaneous materials	
Herbicides	none
Paint	100 gals
Explosives	2,000 lbs

Blackstone Gulch Alternative

Hazardous materials brought on site during construction of the Blackstone Gulch Alternative would be similar to those used for the Lower Roach Gulch Alternative (Table 4.9). It is anticipated that additional explosives may be needed for construction of the delivery tunnel. The potential for impacts from spills or misuse of hazardous material may be slightly greater with this alternative. Potential future impacts from increased agricultural production in the valley would be the same as the Lower Roach Gulch Alternative.

No Action Alternative

There would be no hazardous materials brought on site associated with construction of the dam and reservoir with the No Action Alternative. There would be no increase in potential for hazardous material contamination in the project area with this alternative.

4.13 ADVERSE EFFECTS WHICH CANNOT BE AVOIDED

Implementation of the action alternatives would result in some unavoidable adverse effects. It is unlikely that application of mitigation measures would be totally successful in tempering these effects.

Both action alternatives would be constructed in badlands topography and subsequent inundation and siltation would cause this land form to be permanently lost. The construction of the dam and reservoir would change the appearance of the landscape. The Lower Roach Gulch Dam would be more visible from County Road 91-138 than the Blackstone Gulch Dam.

Inundation and construction of the dam and associated structures would also result in the loss of mixed grassland-sagebrush shrubland, mixed riparian shrub-shrub steppe community, and sparsely vegetated rocky outcrops and ridges. Clearing and excavation within adjacent borrow areas would result in additional loss of upland habitats, primarily mixed sagebrush grassland, until reclamation is successful (best case is approximately 2 to 3 years but successful reclamation may take much longer). This would result in the permanent (dam and reservoir) or temporary (borrow areas) loss of upland terrestrial habitat for a number of wildlife species. Some reduction would occur in the number of animals in local populations of small and relatively immobile species. However, no crucial habitat for larger and more mobile species such as mule deer would be lost and thus no reduction in the number of these species would occur.

Habitat exists for some federally protected species under the Migratory Bird Treaty Act. For the Lower Roach Gulch Alternative, an American kestrel nest was located in the area that would be inundated in 1995. Sufficient alternate nest sites exist that the loss of this nest would not likely reduce the reproductive potential for this species. Construction of the reservoir at Blackstone Gulch site would have the potential to impact two golden eagle nests. One nest is located along the Greybull River within 0.5 miles of the return flow route, and the other is located on a cliff face through which the tunnel would be drilled for the canal route to the reservoir. An American kestrel nest as well as two unoccupied nests also are present on this cliff face. Drilling through this cliff face would likely displace these nesting birds if conducted during the nesting period.

At least 1,000 cfs of flow from the Greybull River could be lost during high flow periods. This could result in reduced flooding and a loss of wetlands in the riparian community along the Greybull River. While these wetlands may be replaced by wetlands associated with the reservoir and delivery canal the wetlands would be in a different setting (upland versus riparian) and a different quality.

Both action alternatives could result in loss of sediment to the Greybull River. The loss of sediment would have the potential to benefit some species (such as trout) and be detrimental to others (warm water species). However, sediment reductions are considered so minor that effects on aquatic organisms are probably not measurable.

Flows at the mouth of the Greybull River would be depleted by an average of 5,480 acre-feet annually and flows at the mouth of Dry Creek would be increased by an average of 2,120 acre-feet annually.

Net depletions to the Bighorn River and Big Horn Lake would be approximately 3,360 acre-feet annually under the proposed operation of the project. Total additional depletions to the system due to evaporation would be approximately 1,700 acre-feet per year. Overall, the depletions should be negligible. However, the addition of flows to Dry Creek could alter this drainage. Additional flows may have a short-term scouring effect on the existing plant community. However, in the long-term, the increased flows should benefit wetlands and riparian plant communities with corresponding benefits to aquatic and terrestrial organisms in the drainage.

Due to the good air quality in the region, construction of the reservoir would have a minor, temporary effect on air quality. Construction would also cause a minor short term increase in noise in the area.

Construction of either reservoir would inundate native range presently being used for grazing and as part of grazing allotments managed by the BLM. The amount of grazing capacity lost to the Lower Roach Gulch Alternative is insignificant. The grazing capacity of the North Blackstone Allotment will be reduced by approximately half if the Blackstone Gulch Alternative is constructed.

Construction of the Blackstone Alternative presents a problem for storage of spoil produced by digging the tunnel. If the spoil is disposed of in the reservoir, the effective life of the reservoir would be reduced. If the spoil is disposed of on uplands, grazing and wildlife habitat would be lost until the spoils are reclaimed. The potential for reclamation of the spoils would be very low.

Impacts to cultural resources are considered unlikely. However, the potential loss is unknown at this time. Impacts to paleontological resources in the Willwood Formation are likely for either alternative.

4.14 RELATIONSHIP BETWEEN SHORT-TERM USE AND LONG-TERM PRODUCTIVITY

For the purpose of this discussion, short-term is defined as the period of construction of the proposed project through final reclamation up to successful, stable revegetation, assumed to take up to 5 years. Long-term productivity refers to the period after the project is completed, mitigation measures are in place, and reclamation of borrow areas is considered a success.

The dam, reservoir, canals and borrow areas would result in the loss of wetlands, grazing and wildlife habitat as described above. Inundation of the upland range would have a slight but insignificant reduction in the long-term grazing potential for the area and a reduction in the area's capacity to support some small immobile species of wildlife and upland native vegetation. Either alternative would result in a long-term increase in the agricultural productivity of the Greybull Valley. Mitigation measures, increased flows in Dry Creek, and increased irrigation would likely increase the total number of acres of wetlands in the valley. However, there would be a long-term loss of riparian wetlands in the Greybull River floodplain.

4.15 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

An irreversible and irretrievable commitment of resources is considered a permanent reduction or loss of a resource, at least for the foreseeable future. A small amount of riparian wetlands maintained by flooding during peak flows would be lost as a result of reduced flows in the Greybull River downstream of the proposed diversion point. Some of these areas are likely to develop into permanent upland. There would also be an irreversible and irretrievable commitment of resources with the proposed project in the increased water lost to evaporation from the reservoir and the delivery canal. The badlands topography, particularly at the dam site, would be lost until natural erosive forces return the topographical characteristic to the landscape once the dam and reservoir are removed. The vegetation and wildlife habitat which presently exists within the dam and reservoir site would also be lost until well beyond the life of the project. Should significant cultural or paleontological resources be discovered during construction, recovery and monitoring activities would be conducted under the direction of the BLM. However, accidental destruction of the these resources would represent an irreversible and irretrievable commitment of resources associated with the project. GEI (1994a) identified 13 borrow areas with a total of 27,767,051 cubic-yards of material for use in construction of the dam, embankments, canal fill, riprap bedding, roadway base material, and other project components. Use of this borrow material for these purposes is considered an irreversible/irretrievable loss of this material.

CHAPTER 5.0 MITIGATION

5.1 INTRODUCTION

The previous chapter described potential environmental consequences from implementing each of the alternatives, including the No Action Alternative. This chapter describes mitigation measures designed to offset adverse environmental impacts that may result from implementing either of the reservoir alternatives.

Adverse environmental impacts identified in Chapter 4 include:

- disposal of dispersive clays and saline material from excavation of the tunnel at the Blackstone Gulch Alternative;
- loss of plant communities;
- impacts to wetlands along the diversion canal, in the area that would be inundated (reservoir site), along the return flow route, and along the river between the diversion and return flow;
- impacts to the aquatic ecosystem from altered Greybull River flows;
- socioeconomic impacts related to housing, law enforcement, and health care;
- loss of cultural resources eligible for nomination to the National Register of Historic Places;
- loss of paleontological resources; and
- impacts to public lands from increased public use at the reservoir site and along routes to the site.

Some impacts identified may be avoided or reduced by implementing conservation practices for protecting resources. Impacts that may be offset by conservation practices include:

- impacts to air quality from fugitive dust raised during construction;
- impacts to nesting raptors from disturbance by construction equipment;
- impacts to the Greybull River from sediment or contaminant-laden runoff at construction sites;
- impacts to the Greybull River aquatic ecosystem from sediment buildup at the diversion dam;
- increased erosion in the Greybull River due to reduced sediment loading in the river;
- impacts to mammalian, avian, and herpetofauna communities in the construction area; and
- potential visual resource impacts from visibility of project features.

5.2 LAND FEATURES

5.2.1 GEOLOGY AND SOILS

Blackstone Gulch Alternative

Disposal of dispersive ciays or highly saline material removed during construction of the diversion tunnel for the Blackstone Gulch Alternative may cause significant impacts to water quality and plant communities. This material could be disposed of and potential impacts mitigated by creating a valley fill in Blackstone Gulch above the high-water line of the reservoir upstream of the tunnel outlet within the ROW. The exposed slopes of the Willwood Formation in this area consist of materials similar to those that would be removed from the tunnel and do not currently support significant vegetation communities. Careful placement of material excavated from the tunnel in a designed fill against the valley side slopes so that drainages are routed around the fill and slopes are maintained at a nonerosive grade would result in a disposal area similar in appearance to and less erosive than surrounding slopes. Review of topographic maps of the area indicates there is ample room to dispose of up to 51,000 cubic yards of material removed from the tunnel. It is anticipated that the quantity of material requiring disposal would be substantially less because some excavated material would be suitable for use in construction of the dam and canal embankments.

5.3 WATER RESOURCES

5.3.1 SURFACE HYDROLOGY

5.3.1.1 Flow Reregulation

Maximum water conservation benefits from flow reregulation could be obtained by constructing and operating a 1,000 cfs diversion canal to either reservoir. However, water supplies to wetlands may be adversely affected between the reservoir diversion point and the return point for outflows from the reservoir. Diversion of flows for reregulation would reduce the flow peaks that occur frequently enough to flood portions of the first terrace above the river and maintain some wetlands. Section 5.6.1 WETLANDS describes mitigation measures for potential wetland losses.

5.3.2 WATER QUALITY

5.3.2.2 Sediment Loading

Lower Roach Gulch Alternative

Operation of the Lower Roach Gulch Alternative should decrease sediment loading in the Greybull River downstream of the reservoir diversion. Mitigation would only be required if

releases of clear water from the reservoir increased erosion in the Greybull River downstream of the reservoir outlet. This is considered unlikely because bypasses of natural flow at the diversion dam should contain sufficient sediment to prevent erosion from increasing significantly. Mitigation of potential effects would be implemented by operation of the sluice gates at the diversion dam to increase sediment discharge from the diversion pool during periods of large reservoir releases, if required.

Blackstone Gulch Alternative

Operation of the Blackstone Gulch Alternative would be similar to that of the Lower Roach Gulch Alternative. Adverse erosional effects due to operations would be mitigated in the same way.

5.4 AIR QUALITY

Impacts to air quality from construction of either reservoir alternative are considered temporary and insignificant and no mitigation would be required. Proper construction site management (such as use of water spreaders to reduce fugitive dust levels and up-keep of equipment maintenance to reduce exhaust emissions) would be employed to reduce temporary impacts to air quality.

5.5 NOISE

Nesting raptors in the project areas may be disturbed by increased noise levels during construction of either reservoir alternative. Mitigation measures for these impacts are outlined in section 5 6.5.1 Raptors. Other noise impacts are considered temporary in nature with no mitigation required.

5.6 BIOLOGICAL RESOURCES

5.6.1 WETLANDS

Lower Roach Gulch Alternative

Wetland restoration, creation, and enhancement are used for mitigating wetland losses. Generally, restoration is re-establishment of wetlands in areas where they previously existed but currently do not, creation is construction of wetlands in uplands or other nonwetland areas, and enhancement is increasing the value and/or function of existing wetlands. Two types of mitigation are generally used, in-kind, or establishing the same type of wetland being lost, and out-of-kind, establishing a different type of wetland. The location of mitigation measures are referred to as on-site, generally in the immediate vicinity of the project within the same watershed, and off-site, or removed from the project area and often in a different watershed.

Mitigation for wetland losses centers around successful creation, restoration, or enhancement of the structure and function of wetlands. Objectives of a successful mitigation plan include establishing a wetland community on the first attempt; meeting regulatory requirements; meeting (or exceeding) expectations of landowners, land managers, and the public; providing food and cover for wildlife; and providing a wetland functioning in the hydrologic system of the site.

Wetlands created as mitigation for losses resulting from the project would require protection. Wetlands on public land could be protected through the land management agencies planning process. Wetlands on private land would need to be permanently set aside through purchase and managed by GVID. As an alternative to fee simple purchase, wetland values could be protected through a conservation easement.

Impacts to wetlands would require a permit pursuant to Section 404 of the CWA. The 404 permit application would specify mitigation design details and a monitoring plan to insure successful creation and protection of mitigation wetlands. The permit application would outline specifics such as the acreage of mitigation required, locations of created wetlands, detailed methods of establishing wetlands, and detailed plans to protect and monitor success of the mitigation.

Implementation of the Lower Roach Gulch Alternative may impact wetlands in four locations: (1) in the area that would be inundated; (2) along the diversion canal route to the reservoir; (3) along the return flow route between the reservoir and the river; and (4) along the river between the points of diversion and return flow.

Wetlands affected in the area to be inundated include 0.36 acre of ephemeral streambed wetlands and 1.80 acres of wetlands associated with a stock pond (Table 5.1). All wetlands in the ephemeral streambed consisted of narrow (generally ≤ 9 foot), linear strips of wetland vegetation on the side(s) of the channel. These small wetlands range in size from 31.5 to 2250 square feet. The most common species associated with wetlands along the streambed are sandbar willow, alkali cordgrass, and inland saltgrass. The 1.80-acre stock pond was constructed by damming an ephemeral streambed. The stock pond was dry at the time of the wetland delineation and completely vegetated. Vegetation within the boundaries of the stock pond included sandbar willow, plains cottonwood, foxtail barley, Chinese tamarisk, softstem bulrush, and Canada thistle.

A total of 0.88 acre of wetlands would be effected by the diversion dam and along the diversion canal route (Table 5.1). The proposed canal alignment crosses six wetlands. An impact zone of 75 feet for construction of the canal was used to calculate impacts (M. O'Grady, SWWRC, pers. commun.). Total area of potential wetland impacts along the canal alignment ranged from 225 to 5625 square feet at each wetland crossing. Wetland crossings include the point of diversion from the Greybull River, where approximately 0.12 acre of two wetlands would be adversely effected. The wetland immediately adjacent to the river is dominated by narrowleaf cottonwood saplings with an understory of wild licorice and Kentucky bluegrass. Immediately adjacent to this wetland is a secondary channel dominated by creeping spikerush and Olney's bulrush. Additional wetland crossings include a small channel dominated by beaked sedge receiving irrigation return flows, a 6-foot-wide irrigation ditch

dominated by creeping spikerush and white clover, a depression within a pasture dominated by Nebraska sedge and receiving water from irrigation return flows, and a crossing of Snyder's Ditch dominated by sandbar willow and Kentucky bluegrass. Approximately 0.60 acre of wetland would be inundated along the Greybull River behind the diversion structure. This wetland is comprised of sandbar willow habitat on a small sandbar and a secondary channel dominated by creeping spikerush.

Table 5.1 Comparison of wetland acreage potentially impacted by each of the reservoir alternatives.

Project Component	Lower Roach Gulch	Blackstone Gulch
Reservoir Site	0.36 acre streambed 1.80 acres stock pond	0.04 acre streambed 0.51 acre stock pond
Diversion Canal Route	0.88 acre	0.40 acre
Return Flow Route	0.57 acre	0.02 acre
Greybull River from Diversion to Return	1.15 acres	1.46 acres
Total	4.76 acres	2.43 acres

A total of 0.57 acre would be effected along the return flow route for this alternative (Table 5.1). Wetlands ranging in size from 9 to 1687.5 square feet are present along the ephemeral streambed. These wetlands are narrow, linear strips of vegetation comprised primarily of sandbar willow, Canada wildrye, alkali cordgrass, narrowleaf cottonwood, wild licorice, inland saltgrass, baltic rush, Olney's bulrush, plains cottonwood, Russian olive, and golden currant.

Total acreage of wetlands potentially effected along the Greybull River between the diversion and return flow points is 1.15 acres (Table 5.1). Wetlands along the river are located in depressions and linear secondary channels. The plant communities of these wetlands are dominated by spikerush, three-square bulrush, Nebraska sedge, and beaked sedge. Overstory species include narrowleaf cottonwood and sandbar willow.

Wetlands along the Greybull River, diversion canal, and within the proposed reservoir site and return flow route have different functional values depending on location and type. In general, wetlands located along ephemeral streambeds within the reservoir area and return flow routes have little functional value due to their small size and sparse vegetative cover. These wetlands serve to stabilize soils where vegetation is relatively dense; however, they occur in only a small fraction of the ephemeral streambeds and do little to control erosion in the gulches. These wetlands provide vegetation diversity in an upland arid environment, and produce seeds and forage for wildlife and domestic livestock. The stock pond in the reservoir area provides a source of water where this resource is generally scarce. The wetland fringe along this stock pond improves water quality by reducing erosion along the shoreline. Plants within the wetland fringe provide seeds and forage for wildlife and livestock. Wetlands along the diversion canal, with the exception of the point of

diversion from the Greybull River itself, are generally small, linear strips of wetland adjacent to irrigation ditches. These wetlands serve to stabilize soil along the ditches and provide forage and seeds for wildlife consumption.

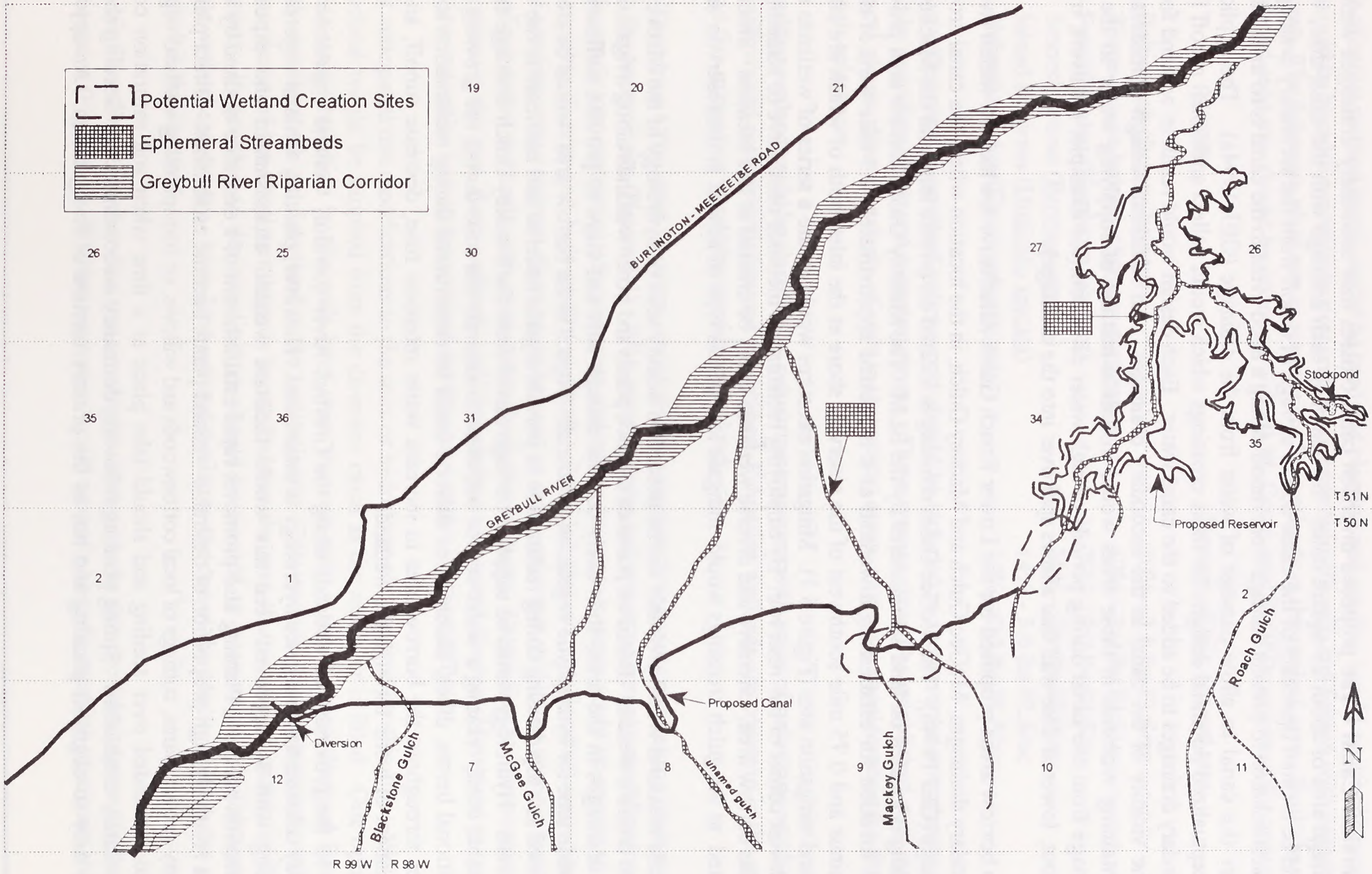
Wetlands along the Greybull River riparian corridor have numerous functions and values. Due to the arid nature of the project area, wetlands and other habitats along the Greybull River riparian corridor contribute significantly to the aesthetic quality of the area. Wetlands immediately adjacent to the river, especially those dominated by sandbar willow and sapling narrowleaf cottonwoods, stabilize soils, reduce bank erosion and improve water quality and fish habitat by reducing sediment loads in the Greybull River through reduced erosion and by trapping sediment during high flows. These wetlands also provide food and cover for many wildlife species. These wetlands were generally classified by the USFWS as palustrine scrub-shrub temporarily flooded wetlands and riverine lower perennial unconsolidated shore seasonally flooded wetlands.

Wetlands in secondary channels are generally comprised of dense mats of spikerush, Olney's bulrush, several species of sedges, and other wetland plants. These wetlands occur on shallow soils and serve to improve water quality and greatly reduce the potential for erosion when spring flows may scour these channels. Seeds produced by plants in these channels provide excellent sources of food for waterfowl and other wildlife, and the plants themselves provide forage for ungulates and livestock. These wetland are generally classified by the USFWS as palustrine emergent seasonally flooded wetlands or palustrine emergent temporarily flooded wetlands.

Most of the sedge meadows found adjacent to the river are generally created by irrigation return flows. These wetlands are generally far enough away from the river that they do not play a major role in erosion control caused by river scouring. These wetlands often have fairly deep soils comprised of clays and sandy clays, rather than shallow, sandy substrates typical of wetlands immediately adjacent to the river, and serve as areas of nutrient retention and groundwater discharge/recharge. During years of extremely high flows, these wetlands have the potential to store large amounts of flood water and reduce potential for flooding further downstream along the river. Vegetation in these wetlands is dense and structurally diverse; therefore, these wetlands provide ideal cover and nesting sites for many species of wildlife. Biomass production in these wetlands is great and they provide extensive forage for wildlife as well as livestock. Seeds produced by wetland plants also provide a significant food source for many wildlife species, especially waterfowl and other birds. These wetlands were generally classified by the USFWS as palustrine emergent seasonally flooded wetlands.

For the Lower Roach Gulch Alternative, mitigation for wetland losses would center around creating in-kind and out-of-kind wetlands on-site. Natural succession in created wetlands is an essential process that eventually leads to more functional wetlands similar to natural wetlands in the area. The project as designed provides opportunities in four locations on-site to create wetlands: (1) along the diversion canal; (2) between the delivery point of the canal and the reservoir (3) along the reservoir shoreline; and (4) along the Greybull River between the diversion and return flow (Figure 5.1).

Figure 5.1 Map of potential wetland mitigation areas at the Lower Roach Gulch Alternative.



Diversion Canal - The proposed diversion canal crosses four secondary drainages with a total drainage area of about 25 square miles. By damming each drainage with the canal dike, wetlands would be created upstream of the canal due to storage of runoff from the secondary drainage. The simplest solution to prevent damage from runoff during a flood event to the canal is to install a culvert under the canal to allow passage of water from the drainage (GEI 1994a). The applicant has conceptualized potential designs for these crossings which would collect additional runoff from the secondary drainages to be added to the canal water. Each design would result in wetland formation in the vicinity of the canal in the secondary drainages. An additional design consideration for maintaining wetlands in these areas would include a method of supplying water to the natural drainage from the canal during periods of high water diversion (for example, a culvert, irrigation turnout, lowered dike wall that allows spill over into the drainage).

Two borrow areas proposed for the Lower Roach Gulch Alternative are located within two of the secondary drainages, McGee Gulch and Mackey Gulch, in the location where the canal crosses the drainage (GEI 1994a). The McGee Gulch crossing is located on private land and the Mackey Gulch crossing is located on land administered by the BLM. The Mackey Gulch borrow area provides an ideal location for establishing a wetland as it is located approximately 0.5 mile west of the canal terminus and 0.75 mile southwest of the reservoir shore at the inlet, both of which are additional wetland mitigation sites (Figure 5.1). Mitigation measures would create a series of wetlands near the southwest corner of the reservoir. By employing reclamation methods conducive to retaining water for this borrow area, extensive and diverse wetlands could be created at this location. Stock ponds created at the gulch crossings would mitigate loss of this type of habitat at the reservoir site.

Specific measures would probably not be needed to modify soils or hydrology of the Mackey Gulch site to create a wetland. Based on presence of stock ponds and other wetlands along irrigation canals and drainages in the area, soils likely contain enough silts and clays to provide sufficient water retention time for hydrophytic vegetation to flourish. Topsoil in the borrow area would be stockpiled and used as a top dressing during reclamation to provide organic material and nutrients in the wetland substrate. Hydrology would be supplied through runoff from the Mackey Gulch drainage and from the canal itself, creating a water source sufficient to saturate the soils during the growing season. Additional berms, dikes, channels, or culverts could be constructed during reclamation to spread water throughout the borrow area to increase water retention time, decrease runoff, and allow movement of water through the wetland.

Due to the proximity of wetlands along the Greybull River corridor, wetland vegetation should quickly colonize this area once hydrology is established. However, planting wetland vegetation and seeding with an approved seed mix would facilitate wetland establishment and expedite the reclamation process. Planting also promotes rapid establishment of a desirable wetland by insuring that a relatively high proportion of desirable wetland plants become established. Direct planting of nursery-grown plants, cuttings of local cottonwoods and willows, or transplanting wetland vegetation is recommended over seeding and should take place at a time when soil saturation could be immediately established. Spring planting following dormancy is recommended. Seeding should be used only to augment planting and not as the primary method of revegetation. An appropriate

mixture of native wetland plants would be used and planting and seeding would occur concurrently. Seeds would be broadcast evenly on prepared areas, covered with soil, and firmed with appropriate equipment. The following plant mix is appropriate for wetlands in the project area. Both the direct planting and seed mix should be reviewed with BLM, Corps, and WGFD personnel for approval.

Species	Percent of mix or seed rate
Baltic rush (Juncus balticus)	20% - 3.0 lbs PLS/ac
Three-square bulrush (Scirpus pungens)	12% - 2.0 lbs PLS/ac
Foxtail barley (Hordeum jubatum)	20% - 3.0 lbs PLS/ac
Smooth brome (Bromus inermis)	20% - 2.0 lbs PLS/ac
Inland saltgrass (Distichlis spicata)	14% - 3.0 lbs PLS/ac
Nebraska sedge (Carex nebraskensis)	14% - 2.0 lbs PLS/ac

Sandbar willow and narrowleaf cottonwood should be included to increase the complexity of the wetland by providing shrub and overstory layers. These species should be established with cuttings from local plants. Due to salinity of soils in the project areas, a primary consideration for the seed mix is salt tolerance.

The resulting wetland could be classified as palustrine emergent with areas of palustrine scrub-shrub where willows and cottonwoods become established. Palustrine wetlands are common in the project area and this mitigation would be considered in-kind.

Canal Terminus - The canal terminus would discharge water directly into the natural drainage that leads to the reservoir site (Figure 5.1). With proper design and some topography modifications (for example, grading or contouring adjacent areas and minor drainages), water could be spread to other areas creating diverse and high-quality wetlands. Provided that water velocities are reduced to prevent scouring, cross channel dikes could be used to impound water within the channel creating a series of palustrine wetlands with open water along this drainage. Depending on the magnitude of modifications in this area, these wetlands could be quite extensive and diverse. However, potentially high water velocities may make wetland development at this location difficult.

It is not anticipated that modifications to the soils or hydrology are required for this area. Water for the wetland would be supplied from the diversion canal as the reservoir is filled. One option to facilitate water retention by the soils is to treat the area with a top-dressing dredged from the currently existing stock pond wetland in the reservoir site. This wetland, located approximately 1.5 miles northeast of the canal terminus, is located within the area that would be inundated by this alternative. Vegetation as described above should be planted to encourage establishment of a desirable wetland community. An in-kind wetland similar to the one at the Mackey Gulch site would be created in this location.

Reservoir Shoreline - The shoreline area around the reservoir basin also provides a potential wetland mitigation area (Figure 5.1). Wetland vegetation would naturally become established around the lake

shore much like it has at Upper and Lower Sunshine reservoirs. Wetlands established along the shoreline would probably not be as high in quality as those established at the canal crossing or the canal terminus primarily due to rapid fluctuation of the water level during periods of reservoir filling and discharging. With some modifications such as island creation, wetland vegetation planting, and construction of water retention dikes, the size and value of these wetlands should increase.

Excess borrow material from canal construction (GEI 1994a) or other areas would be used to build islands within the reservoir. These islands would be covered with a topsoil dressing and planted with a mixture of upland and wetland species in a gradient from the higher portions of the islands to areas below the high-water line. This gradient would provide valuable cover for wildlife and potential nesting habitat for waterfowl.

Areas of the reservoir shore which experience less water fluctuation and a more constant water supply (for example, areas adjacent to the inlet) would be planted with wetland vegetation to facilitate wetland establishment. Establishing abundant wetland communities along the reservoir shore near the inlet would contribute to the wetland complex created by establishing wetlands at the previous two sites.

A third method of creating wetlands around the reservoir shore would involve construction of berms and dikes below the high-water line which would temporarily detain water as the reservoir level drops, thus maintaining saturated soil conditions for longer periods. These areas could also be planted with wetland vegetation to expedite the wetland formation process.

It is anticipated that a lacustrine wetland fringe (out-of-kind wetland) would become established around the reservoir shore similar to the Upper and Lower Sunshine reservoirs. Given that topography of the reservoir area is steeper, the fringe generally would be narrower.

Greybull River Corridor - Operation of the diversion canal to divert flows to storage could have an adverse effect on wetlands supplied by high-frequency flood peaks in the approximately 6-mile reach between the diversion and the return flow points for the reservoir. Modeling of the affected stream reach combined with mapping of existing wetlands indicate that reduction of yearly flood peaks by up to 1,000 cfs may reduce water supplies to a few wetlands along the first terrace above the Greybull River totaling approximately 1.15 acres. Wetlands would be created along the Greybull River corridor to mitigate these impacts.

There are opportunities to create maintenance-free wetlands or enlarge existing wetlands along the river in old oxbows, secondary channels, and in uplands that currently do not support wetlands (Table 5.2). Wetlands could be created by excavating depressions in upland areas so they receive water during high flows or ground water through seepage. Additionally, existing wetlands could be enlarged though excavation to widen narrow wetland channels. Wetland vegetation is prevalent in the riparian corridor and in-kind on-site wetlands would become quickly established in the absence of seeding or planting.

Table 5.2 Locations, landowners, and descriptions of opportunities to create wetlands along the Greybull River within the Lower Roach Gulch or Blackstone Gulch project area.

Location	Landownership	Description
Lower Roach Gulch		
T. 50 N., R. 98 W., sec. 6, NE¼	BLM	enlarging existing narrow wetland channels or excavating depression in uplands between channels and river
T. 51 N., R. 98 W., sec. 28, N½ of SW¼	Private	excavating depression in an upland area between two narrow wetland channels
T. 51 N., R. 98 W., sec. 23, SW¼ of NW¼	Private	excavating depressions in an upland area between a wetland oxbow and the river
Blackstone Gulch		
T. 50 N., R. 98 W., sec. 6, NE¼	BLM	enlarging existing narrow wetland channels or excavating depression in uplands between channels and river
T. 50 N., R. 99 W., sec. 12, NW¼	Private	excavating depressions in a large upland area between the river and a large irrigation return flow wetland

Blackstone Gulch Alternative

Implementation of the Blackstone Gulch Alternative would impact wetlands in three locations: (1) the area that would be inundated; (2) along the return flow route between the reservoir and the river; and (3) along the river between the points of diversion and return flow.

Affected wetlands in the area to be inundated include 0.04 acre of streambed wetlands and 0.51 acre of wetlands associated with three stock ponds (Table 5.1). Wetlands along the streambed consist of narrow, linear strips of wetland vegetation on the sides of the channel. These small wetlands range in size from 117 to 675 square feet. Four of the five wetlands are isolated communities along the channel. These wetlands are comprised entirely of either sandbar willow or narrow-leaf cottonwood saplings. The fifth wetland in the channel has formed behind the dam of a stock pond. This wetland is dominated by creeping spikerush, Nuttall's alkaligrass, Olney's bulrush, and foxtail barley. There are three stock ponds in the site which total approximately 2.2 acres. The ponds were constructed by damming ephemeral streambeds. All three ponds have a fringe of wetland vegetation around the perimeter totaling 0.51 acre. Common wetland species in these fringes include saltmarsh bulrush, narrow-leaf cottonwood, foxtail barley, creeping spikerush, sandbar willow, Nuttall's alkaligrass, Olney's bulrush, softstem bulrush, curly dock, wild licorice, baltic rush, and beaked sedge.

No wetland impacts would occur along the diversion canal route; however, approximately 0.4 acre of riparian wetland would be inundated along the Greybull River behind the diversion structure (Table 5.1). A total of 0.02 acre of wetlands would be impacted along the return flow route for this alternative. One wetland is within a channel receiving irrigation water and is approximately 150 feet

long and 3 feet wide. It is dominated by creeping spikerush, foxtail barley, and Olney's bulrush. The return flow canal would also cross Snyder's Ditch. There is a small, 5-foot-wide strip of wetland vegetation adjacent to the ditch dominated by sandbar willow, Kentucky bluegrass, wild licorice, and quackgrass.

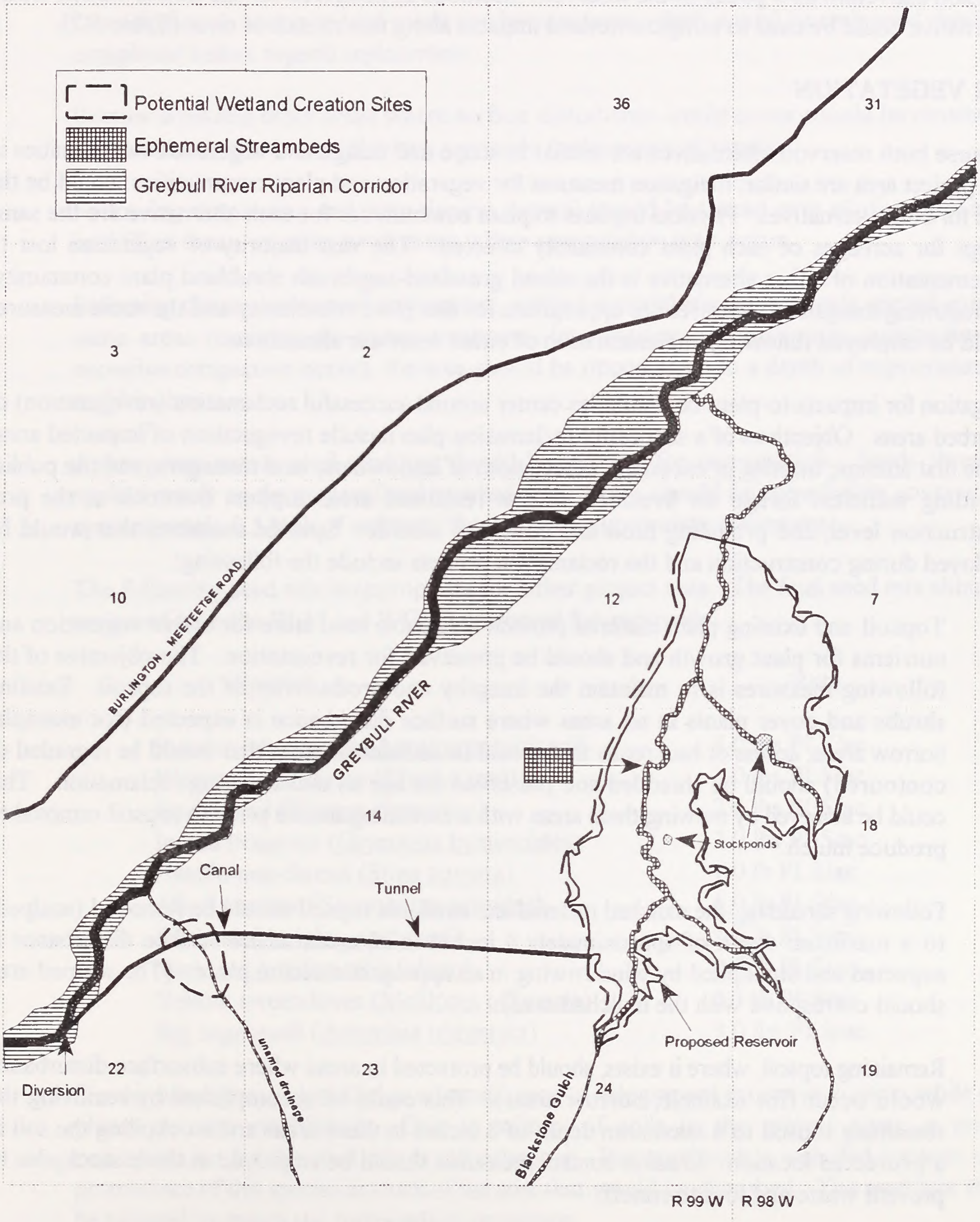
Total acreage of wetlands potentially effected along the Greybull River between the diversion and return flow points is 1.46 acres (Table 5.1). Wetlands along the river are located in depressions and linear secondary channels. Plant communities in these wetlands are dominated by spikerush, three-square bulrush, Nebraska sedge, and beaked sedge. Overstory species include narrowleaf cottonwood and sandbar willow.

Wetlands associated with the Blackstone Gulch Alternative generally have the same functions and values as similar wetlands associated with the Lower Roach Gulch Alternative. For the Blackstone Gulch Alternative, mitigation for wetland losses would involve creating new in-kind and out-of-kind wetlands on-site. Mitigating losses along the Greybull River would involve wetland creation. The project as designed provides opportunities to create wetlands along the diversion canal, and along the reservoir shoreline (Figure 5.2). The 4.1-mile stretch of river between the diversion and return flow points also provides opportunity for wetland creation in the Greybull River riparian corridor.

Diversion Canal - Operation of the Blackstone Gulch Alternative would be similar to that of the Lower Roach Gulch Alternative. Diversions to the Blackstone Gulch Alternative would flow through a 1-mile reach of canal and then through a 1-mile tunnel to the reservoir. The 1-mile canal crosses an upland bench with only one small secondary drainage with a drainage area of approximately 0.7 square mile. The potential for creation of a high-quality wetland at the canal crossing without supplemental water (only using runoff) would be minimal due to the limited water supply and small size of the drainage. However, by diverting water from the canal, a much larger portion of this upland terrace could be converted to wetland (Figure 5.2). Using methods similar to those described for the Lower Roach Gulch Alternative (for example, spreader dikes, berms, culverts), water could be spread over a larger area and retained to saturate soils before it flows back to the Greybull River. Loss of the three stock ponds that would be inundated by this alternative could be mitigated by creation of similar-sized stock ponds in an adjacent gulch such as Mackey Gulch.

Reservoir Shoreline - The tunnel discharges at the high-water line of the reservoir in a small tributary to Blackstone Gulch. There is no potential for creating wetlands with check dams at the outlet of the tunnel. However, methods similar to those described for the Lower Roach Gulch Alternative could be used to create lacustrine wetlands (out-of-kind) around the Blackstone Reservoir shore. Based on the proposed highwater line of this alternative, one natural island in the reservoir would be created from a hill. This is an ideal area for using some of the methods described for the Lower Roach Gulch Alternative as it naturally prevents livestock from grazing in this area during periods of high water.

Figure 5.2 Map of potential wetland mitigation areas at the Blackstone Gulch Project Alternative.



Greybull River Corridor - Operation of the diversion canal to divert flows to storage could have an adverse effect on wetlands supplied by high-frequency flood peaks in a 4.1-mile reach between the diversion and return flow points of the reservoir. Methods as described for the Lower Roach Gulch Alternative could be used to mitigate wetland impacts along this stretch of river (Table 5.2).

5.6.2 VEGETATION

Because both reservoir alternatives are similar in scope and design and vegetation communities in each project area are similar, mitigation measures for vegetation and plant communities would be the same for both alternatives. Physical impacts to plant communities for each alternative are the same except for acreages of each plant community affected. The vast majority of vegetation lost to implementation of either alternative is the mixed grassland-sagebrush shrubland plant community. The following mitigation measures are appropriate for this plant community and the same measures would be employed following implementation of either reservoir alternative.

Mitigation for impacts to plant communities center around successful reclamation (revegetation) of disturbed areas. Objectives of a successful reclamation plan include revegetation of impacted areas on the first attempt; meeting or exceeding expectations of landowners, land managers, and the public; providing sufficient forage for livestock so that reclaimed areas support livestock at the pre-construction level; and providing food and cover for wildlife. Specific measures that would be employed during construction and the reclamation process include the following:

- Topsoil and existing plant material provide a valuable seed store for native vegetation and nutrients for plant growth and should be preserved for revegetation. The objective of the following measures is to maintain the integrity and productivity of the topsoil. Existing shrubs and cover plants in all areas where surface disturbance is expected (for example, borrow areas, access or haul roads that would be reclaimed, areas that would be regraded or contoured) should be shredded and preserved for use as mulch during reclamation. This could be achieved by mowing these areas with a shredding device prior to topsoil removal to produce mulch.

- Following shredding, the mulched material and available topsoil should be removed (scalped) to a maximum depth of approximately 4 inches in all areas where surface disturbance is expected and stockpiled by wind rowing in an appropriate secure place. (The scalped area should correspond with the mulched area).

- Remaining topsoil, where it exists, should be protected in areas where subsurface disturbance would occur (for example, borrow areas). This could be accomplished by removing the remaining topsoil to a maximum depth of 8 inches in these areas and stockpiling the soil in a protected location. Erosion control measures should be employed at these stockpiles to prevent waste and loss to runoff.

- Erosion should be controlled in all disturbed areas during construction and reclamation phases in accordance with a storm water runoff plan.

- Deep ripping on access or haul roads and borrow areas which would be reclaimed should be completed before topsoil replacement.

- Borrow areas and other areas where surface disturbance would occur should be returned to approximately their original contour prior to replacement of topsoil.

- Following contouring and deep ripping, topsoil should be spread over all disturbed areas, backfilled areas, or other work areas where revegetation is to occur.

- Following disking and topsoil replacement, scalped material should be evenly spread over the same areas receiving the above treatments in a manner that minimizes compaction. If excessive compaction occurs, the area should be ripped again to a depth of approximately 8 to 10 inches.

- Appropriate native seed mixtures should be selected for revegetation. Seeds should be applied evenly on the prepared and mulched area. Seeds should be immediately covered with approximately 0.5 inch of soil and "firmed" with appropriate equipment.

The following seed mix is appropriate for either project area. The final seed mix should be reviewed with the BLM and WGFD personnel for approval.

Species	Rate
Slender wheatgrass (Agropyron triticem)	4.0 lbs PLS/ac
Western wheatgrass (Elymus smithii)	3.0 lbs PLS/ac
Squirreltail (Elymus elymoides)	2.0 lbs PLS/ac
Indian ricegrass (Oryzopsis hymenoides)	2.0 lbs PLS/ac
Needle-and-thread (Stipa comata)	1.0 lb PLS/ac
Alkali sacaton (Sporobolus aeroides)	1.0 lb PLS/ac
Saltbush (Atriplex gardeneri)	1.0 lb PLS/ac
Yarrow (Achillea millefolium)	0.5 lb PLS/ac
Yellow sweetclover (Melilotus officinale)	0.5 lb PLS/ac
Big sagebrush (Artemisia tridentata)	3.0 lbs PLS/ac

Slender wheatgrass is included as a "nurse" crop to help prevent excessive erosion while other plants become established. Due to salinity of soils in the project areas, a primary consideration for the seed mix is salt tolerance. Big sagebrush is included because of the prominence of this species in much of the area that would be disturbed. The seed mix should be tailored to match the surrounding vegetation.

- Shrubs should be seeded or shrub islands transplanted to areas where heavy shrub growth was removed. Locations of shrub islands should be determined on a site-specific basis after replacement of scalped material. Islands should be irregular in shape and size. Nursery grown plants should be at least 2 years old, free of mechanical or chemical damage, and disease free. An alternative to nursery plants is native shrubs salvaged from construction areas prior to disturbance. These plants should be moved to safe storage while still dormant and kept in a bound soil ball large enough to minimize stress to the plant.

- Fall planting for revegetation is recommended. Topsoil replacement measures should be completed prior to the fall season in preparation for the fall planting.

- Noxious weed control post-revegetation should follow BLM specifications.

- Successful revegetation is dependent on precipitation and adequate reclamation measures. A reclamation monitoring plan should be established and implemented for three years post-construction to insure successful reclamation has occurred.

5.6.3 WILDLIFE

5.6.3.1 Mammals

Construction of either reservoir alternative is likely to modify mammalian species composition in the project area. With successful reclamation of the plant communities as described above, no long-term detrimental effects are expected to the mammalian community for either alternative. Short-term impacts to the mammalian community would be reduced by minimizing impact to habitat adjacent to construction areas by vehicles and heavy machinery.

5.6.3.2 Birds

As with mammals, construction of either reservoir alternative is likely to modify avian species composition in the project area. With successful reclamation of plant communities as described above, no long term detrimental effects are expected to the avian community for either alternative. Short-term impacts to the avian community would be reduced by minimizing impact to habitat adjacent to construction areas by vehicles and heavy machinery.

5.6.3.3 Reptiles and Amphibians

The overall effect of either reservoir alternative would likely increase populations of amphibians and decrease populations of reptiles in the project area. With successful reclamation of plant communities as described above, no long term detrimental effects are expected to the reptile or amphibian community for either alternative.

5.6.4 AQUATIC RESOURCES

Lower Roach Gulch Alternative

No water quality changes that could cause adverse effects to the aquatic biological community of the lower Greybull River are expected to occur; therefore, mitigation for water quality impacts is not required. Based upon the WEST Team's OPSTUDY hydrologic modeling of present and future flow scenarios with the Lower Roach Gulch Alternative and a 50 cfs bypass flow at the diversion dam, Greybull River flows are expected to remain relatively unaltered; therefore, no mitigation for river flow impacts is required.

Construction of the diversion dam could block fish migration in the Greybull River. Two mitigative measures could be used to offset impacts of the diversion dam on fish movement and migration in the Greybull River. First, fish passage at the diversion dam could be included as part of the diversion dam design and operation. The structure's design and operation should allow both game and nongame species to pass. Second, minimum bypass flows would have to be present. An agreement entered into by GVID, WWDC, and WGFD insures that a minimum bypass flow of 50 cfs or inflow, whichever is less, would be maintained at the diversion dam.

Certain management strategies and mitigation measures have already been integrated into the proposed project, or agreed upon, to reduce some of the adverse effects to the Greybull River expected to occur as a result of project implementation. These measures include the following:

- The reservoir would be flushed during peak runoff periods to reduce the potential adverse effects from increased suspended sediment loads released to the river

- Sediments that accumulate behind the diversion structure would be flushed periodically during high flow periods. Flushing should occur as often as practical.

- Lower Roach Gulch Reservoir would be filled primarily during high runoff periods and a 50 cfs bypass at the proposed diversion structure would be maintained to prevent potential adverse impacts due to dewatering.

- Water discharged from Lower Roach Gulch Reservoir would be conveyed to the Greybull River through the existing gulch channel. The channel would be armored (rip rap) to prevent erosion due to heavy flows.

- The GVID has entered into an agreement with WWDC and WGFD to refrain from modifying future operations in a way that would impact the existing 5 cfs bypass flows in the Greybull River located at the confluence with the Wood River.

- The GVID has entered into an agreement with WWDC and WGFD to refrain from modifying it future operations in a way that would impact the existing 15 cfs bypass flows in the Wood River located at the confluence with the Greybull River.

Although no adverse effects are expected to the trout fishery in Upper Sunshine Reservoir, GVID, WWDC, and WGFD have entered into an agreement that GVID would maintain a 5,000 acre-feet minimum pool in Upper Sunshine Reservoir, with allowances to invade the pool when GVID deems it necessary during drought conditions or for safety reasons. When GVID projects that invasion of the minimum pool is likely, at least a 15-day notice would be provided, when practicable, to WGFD and WWDC. At the commencement of operations of the proposed Greybull Valley Dam and Reservoir Project, GVID has agreed to establish through WWDC an interest-bearing account in the amount of $15,000 to provide resources for restocking Upper Sunshine Reservoir when the minimum pool is invaded. For each invasion of the minimum pool, GVID has agreed to provide a payment to WGFD from the account in the amount of $5,000. If the account is depleted, GVID would make required payments from other sources. The GVID has agreed to use the Upper Sunshine Reservoir minimum pool as the reservoir of last resort when providing downstream irrigation deliveries.

<u>Blackstone Gulch Alternative</u>

Because the Blackstone Gulch Alternative is similar in scope and operation to the Lower Roach Gulch Alternative, adverse effects to the Greybull River from this alternative are expected to be similar to those caused by the Lower Roach Gulch Alternative. Therefore, mitigation measures to offset these impacts would be similar.

5.6.5 SPECIES OF SPECIAL INTEREST

5.6.5.1 Raptors

Mitigation measures for impacts to raptors would be similar for both reservoir alternatives. The primary impact of the proposed project is disturbance and potential disruption of nesting raptors in the project area. Mitigation for these impacts would be dependent on timing of construction and status of individual nests. Assuming that reservoir construction would overlap the raptor breeding season, typical mitigation would include the following measures:

- A survey for raptor nests would be conducted in the project area prior to construction and prior to leaf-out along the riparian corridor so that nests could be easily detected. The survey could be performed from the ground or by air from a helicopter. Locations of all nests would be mapped in relation to project components and an assessment made about the potential for disturbance. All nests located would be monitored for activity by raptors on a regular basis during the breeding season.

- The BLM and USFWS recommend avoidance as the primary means of alleviating impacts to nesting raptors. This would require that construction within 0.5 mile of

an active raptor nest be delayed until the nesting effort has been completed for the year (that is, the young have fledged or the nest fails).

- In the event that a raptor nest would be taken (for example, it is located in the area to be inundated, in a tree that would be cut down) a special purpose permit would be required from the USFWS for moving the nest to a locality not impacted. The need for these measures would be assessed on a case by case basis depending on the raptor nest survey. Inactive nests may be moved at any time following acquisition of a permit. Active nests may be moved following completion of the nesting effort and acquisition of a permit.
- Additional mitigation measures (for example, constructing additional nesting habitat or sites) may be required by the USFWS for permit acquisition and would be determined through consultation during the permitting process.

5.7 LAND USE

5.7.1 LIVESTOCK GRAZING

Implementation of either reservoir alternative would result in the loss of AUMs from the grazing allotments in which the reservoirs would occur. The BLM grazing permits for the allotments would be adjusted to reflect the decrease in AUMs. The grazing permittees would be required to reduce their herds by the number of lost AUMS and would be given 2 years notification of the change. To mitigate these losses, the affected permittee could request a new allotment from the BLM if available.

5.8 SOCIOECONOMICS

5.8.1 HOUSING

Lower Roach Gulch Alternative

The Lower Roach Gulch Alternative would result in a need for temporary housing accommodations for relocating construction workers and administrative personnel over the 2-year construction period. Approximately 81 housing units would be needed during the first year of construction and 115 during the second year. Because there is very little rental housing available in the project area, a housing mitigation plan is recommended to insure that temporary housing would be available for relocating workers. In the absence of such a plan, undesirable environmental impacts may result from workers camping on public and private lands in the area without adequate sanitation facilities. Negative impacts on recreational resources may also result if workers attempt to make long-term use of public camping facilities in the area.

Two options are available to mitigate local housing shortages. The first option would be for the construction contractor to provide housing for relocating workers at a temporary camp near the construction site. This option would alleviate housing shortages, but would be costly and could create undesirable environmental impacts through increased human use of rural areas around the construction site.

The second option would be to lease and possibly subsidize the price of existing campground and motel units in communities surrounding the construction site. This option would minimize undesirable environmental impacts. Lease arrangements for such units would be necessary because of heavy use during summer months by tourists traveling to and from Yellowstone National Park, the Bighorn National Forest, and Bighorn Canyon National Recreation Area. Subsidization of rates may be necessary because many of these units rent for high nightly rates during the summer months. Workers employed on road construction crews west of Cody during the summer of 1995 were reluctant to pay the high nightly fees charged by Cody area commercial campgrounds. Subsidizing rental rates for existing motel and campground units may be less costly than constructing temporary living facilities near the construction site.

Blackstone Gulch Alternative

A housing mitigation plan would also be needed for the Blackstone Gulch Alternative, which would employ approximately 10 percent more workers during a 2-year construction period. Temporary housing needs for this alternative would approximate 90 units during the first construction year and 125 units during the second year. A housing mitigation plan similar to that suggested above for the Lower Roach Gulch Alternative is also recommended for the Blackstone Gulch Alternative.

5.8.2 LAW ENFORCEMENT

Lower Roach Gulch Alternative

Construction of Lower Roach Gulch Reservoir would place increased demands on law enforcement in rural areas of Park and Big Horn counties. Potential law enforcement problems include drinking and driving along roads leading to and from the construction site and bar fights in communities surrounding the site. Although the Park County Sheriff's Department is adequately staffed, the Big Horn County Sheriff's Department may require an additional deputy to handle increased law enforcement loads during project construction. If funding for an additional deputy is not forthcoming from county resources, some mitigation may be necessary. This mitigation could take the form of additional security personnel hired by the contractor or a subsidy to the sheriff's department to hire additional personnel.

Blackstone Gulch Alternative

The construction site for the Blackstone Gulch Alternative is closer to Cody than the Lower Roach Gulch site, and thus may shift some of the law enforcement burden of the project from Big Horn

County to Park County. The determining factor would be the locations where housing is made available for relocating workers. If housing for relocating workers is made available in Cody, no law enforcement mitigation plans should be necessary. If housing is provided in Basin and Greybull, however, this alternative may require a law enforcement mitigation plan similar to that for the Lower Roach Gulch Alternative.

5.8.3 HEALTH CARE

Lower Roach Gulch Alternative

The Lower Roach Gulch Alternative would place increased demands upon emergency medical care providers because of the potential for construction-related accidents at the site. To mitigate this possibility, some type of emergency medical response capability should be maintained on or near the construction site. This capability could take the form of emergency medical technicians and an ambulance maintained by the contractor at the site. Alternatively, the contractor could subsidize the Burlington Fire Department's ambulance and volunteer emergency medical team to respond to accidents at the site.

Blackstone Gulch Alternative

The Blackstone Gulch Alternative would require mitigation measures similar to those suggested for the Lower Roach Gulch Alternative.

5.9 CULTURAL AND PALEONTOLOGICAL RESOURCES

Lower Roach Gulch Alternative

Fifteen previously unrecorded cultural sites and two previously recorded cultural sites were found in areas surveyed for the reservoir and borrow areas in 1995 and 1996. Of these sites, two are considered eligible for nomination to the National Register of Historic Places and one is of unknown eligibility pending evaluative test excavation. Construction impacts to cultural resources in almost all cases completely destroy the cultural resources. For those sites recommended for evaluative test excavation (that is, sites with sufficient deposition to warrant testing to determine the nature and extent of subsurface cultural remains), testing would either show that there are no intact, buried, scientifically valuable cultural remains, or show the presence of significant buried remains. In the former case, the site becomes not eligible and there is consequently no effect. In the later case, mitigative measures would be developed to recover the intact, buried cultural remains.

A mitigation or data recovery plan would be developed that would specify up to 100 1-meter-square excavation units be placed at a site. These excavation units would be excavated in specified levels or depths with all artifacts or structures being plotted in three-dimensional space within each unit. Other subsurface exploration may be recommended such as trenching with a backhoe to determine

depth and extent of deposits and sediments contained therein. These data form the basis for interpretation of prehistoric activities at the site. The mitigation report would summarize, analyze, and interpret data recovered from each unit and for the site as a whole. Once the mitigation phase is completed, construction may proceed pending approval of the regulatory authority.

Potential impacts to paleontological resources are considered substantial due to the presence of exposed and buried Willwood Formation stratigraphy in the project area. A paleontological resources plan would be developed for the selected alternative to mitigate potential impacts. The plan would include:

- a survey of the selected alternative project area including the diversion dam, canal, reservoir site, dam site, return flow route, borrow areas, construction areas, access roads, and other project features to locate exposed paleontological resources and areas where buried resources are likely;
- provisions for salvage of identified paleontological resources encountered on the surface during the survey;
- provisions for recovery and protection of buried fossil deposits in likely areas or encountered during construction; and
- a system for monitoring construction activities and a contingency plan if buried resources are encountered.

Blackstone Gulch Alternative

Seven previously unrecorded cultural sites were found in areas surveyed for the reservoir in 1995 and 1996. All of these sites are considered not eligible for nomination to the National Register of Historic Places. Once regulatory agencies have agreed with recommendations of not eligible for any given cultural site, there is then no effect, and no additional action on these sites need be taken. Thus, for the Blackstone Gulch Alternative, there is no effect on cultural resources and no mitigation is required. Mitigation for impacts to paleontological resources would be the same as for the Lower Roach Gulch Alternative.

5.10 RECREATIONAL RESOURCES

5.10.1 FISHING

Lower Roach Gulch Alternative

The Lower Roach Gulch Alternative would slightly enhance the quality of area fisheries with the mitigation agreement between GVID, WGFD, and WWDC in place as described in Section 4.10.1. That agreement insures that depletions to the upper Greybull and Wood rivers would not be increased to the detriment of those fisheries. It also insures that the most popular fishery in the valley, Upper Sunshine Reservoir, would be operated as storage of last resort for irrigation, insuring that it would

not be drawn down to the detriment of the fishery more frequently than now occurs. Some positive recreation benefits would accrue from guaranteed public access and creation of a fisheries enhancement fund for Upper Sunshine Reservoir.

Blackstone Gulch Alternative

This alternative involves the same fisheries mitigation considerations as the Lower Roach Gulch Alternative.

5.10.2 NONCONSUMPTIVE RECREATION

The reservoir would not be stocked with fish. The most likely use of the reservoir is nonconsumptive recreation such as boating and sightseeing. Impacts from nonconsumptive recreation would be similar for either reservoir alternative. Increased public use of the reservoir site and access across public land may cause impacts through off-road vehicular traffic, litter, and other human use related impacts (for example, vandalism or poaching). Due to lack of a public fishery at the reservoir, public access may be less in comparison to other reservoirs in Park County. Mitigation to offset impacts resulting from increased human use would center around education and precluding public access to certain areas. Mitigation would include:

- Fencing and gating the dam and operation facilities to prevent public access.
- Providing an access road to the reservoir and parking area near the reservoir shore.
- Signing the access road and parking area to prevent unnecessary trespass on adjacent private lands and request users to pack out trash and other refuse.
- Fencing and signing dangerous areas (for example, sheer walls and steep drops to the reservoir, two-track routes which run into the reservoir) for public safety.
- The BLM has the option of creating an access route across public lands. Maintenance and monitoring of this route would come under the BLM Grass Creek Resource Management Plan. The shorter the route the less potential exists for off site impacts along the access route.

5.11 VISUAL/AESTHETICS

Lower Roach Gulch Alternative

Visual impacts center around the visibility of constructed project components such as the dam, diversion dam, canal, and associated operation facilities. As revegetation occurs, visual impacts would be reduced. Although visual impacts are not considered significant, certain recommendations implemented during project construction could offset visual impacts. Mitigation for visual impacts centers around blending project components into the surrounding environment. Mitigation measures include:

- Obliterating abrupt angles and sharp lines in constructed features to the extent possible (for example, rounding contours of the dam and canal berms).
- Revegetation (see section 5.6.2 VEGETATION)
- Using natural colors for painted facilities.
- Using vegetation to obscure project features where feasible (for example, planting trees along the river corridor to obscure the diversion dam)

Blackstone Gulch Alternative

Visual impacts from the Blackstone Gulch Alternative are similar to Lower Roach Gulch and mitigation measures would be similar. The tunnel from the diversion canal to the reservoir may be visible depending on the extent of vegetation loss along the river. Mitigation for this visual impact would involve planting cottonwoods along the river to obscure the tunnel entrance.

5.12 HAZARDOUS MATERIAL

Impacts from hazardous materials on site would arise if a spill or misuse of the material occurs. Mitigation for use of hazardous materials for project construction and implementation center around education and proper use of materials and would be the same for either reservoir alternative.

Mitigation measures include:
- details of the types and quantities of hazardous materials used, stored, transported, produced, or disposed of in conjunction with the project and contingency plans for releases, spills, fires, or explosions would be included in the POD;
- maintaining Material Safety Data Sheets on file at project operations headquarters;
- proper storage of hazardous materials;
- fueling and lubricating of construction and transportation equipment should take place only in a designated area;
- adherence to proper management and handling procedures for hazardous materials and waste;
- following manufacturers suggested guidelines for use and disposal of hazardous materials;
- proper training and education of employees using hazardous materials during project construction and implementation; and
- compliance with the NPDES permit.

CHAPTER 6.0 CONSULTATION AND COORDINATION

6.1 INTRODUCTION

The NEPA process requires that all individuals, organizations, agencies or other entities interested in or potentially affected by the proposal be provided the opportunity to participate in the environmental analysis. The following chapter describes the lead agencies in the NEPA process; the team responsible for preparation of the EIS; the scoping and issues identification process employed in the NEPA process; and participating agencies, organizations, individuals, and others.

6.2 TEAM ORGANIZATION

An interdisciplinary team of consultants and government agencies was responsible for the preparation of the Greybull Valley Dam and Reservoir project EIS. The BLM, Worland District, and the Corps, Omaha District, acted as co-lead agencies for the NEPA process, with the BLM as the primary lead agency. WEST was the lead consultant to the BLM and Corps responsible for the preparation of the EIS. A team of consultants supervised by WEST aided in the EIS preparation.

6.2.1 BLM AND CORPS CO-LEAD AGENCIES

The proposed project involves action by both the BLM and the Corps: a right-of-way application to the USDI, BLM pursuant to Section 5 of the Federal Land Policy and Management Act (1976) and implementing regulations 43 CFR, part 2800; and a permit from the Corps pursuant to Section 404 of the Clean Water Act for the discharge of dredged or fill material into the waters of the U.S. Therefore, the involved agencies acted as co-lead for the NEPA process. The BLM was chosen as the primary lead because of the Worland District Office's proximity to the project.

6.2.1.1 BLM Primary Lead Agency

The BLM Interdisciplinary Team members include the following individuals:

Don Ogaard	BLM Project Manager, NEPA Compliance
Jamie Sellar-Baker	Interdisciplinary Team Leader, Surface Protection
Marian Atkins	Wildlife, Threatened & Endangered Species
Dave Baker	Recreation
Bill Glover	Geology
Jim Honn	Engineering, Construction
Steve Till	Realty
Chet Wheeless	Aquatic Biology, Fisheries

John Whitehurst	Cultural Resources
Cameron Henrichsen	Range, Grazing
Bill Wilson	Hydrology

6.2.1.2 Corps

Individuals in the Corps Planning and Regulatory Branches in Omaha and Cheyenne who contributed to the EIS were:

Planning

Candace Thomas	Environmental Analysis Branch Chief, EIS Director
Becky Latka	Technical Manager, Environmental Resources Specialist
Rick Miner	Economics
David Vader	Native Americans
Becky Otto	Archaeology

Operations

Dick Gorton	Regulatory Branch Chief, Project Director
Chandler Peter	Wyoming Regulatory Office, Project Manager

6.2.2 WEST CONSULTING TEAM

WEST organized and managed an interdisciplinary team of experts to facilitate preparation of the EIS and provide expertise in areas of concern. Following is a list of preparers and the expertise that they provided.

Consulting Team Members:

Western EcoSystems Technology, Inc. (WEST)

Dale Strickland	Team leader, agency liaison, project management, purpose and need, alternative analysis, document preparation and editing
David Young	Wildlife, threatened and endangered species, wetlands, air quality, noise, visual/aesthetics, grazing, biological assessment, document preparation, editing, and photography
Greg Johnson	Wetlands, vegetation, wildlife, threatened and endangered species, biological assessment, noise, air quality, recreation, land use, document preparation, and editing

Clayton Derby	Wetlands, hazardous materials, air quality, visual/aesthetics, simulations, document editing
Wally Erickson	Quality control, data analysis, mapping, graphing, digitizing
Robin Vinzant	Project administration, document preparation

Bear West

Dennis Earhart	NEPA compliance, scoping, alternatives analysis, public involvement

Aqua Terra Consultants, Inc.

John Buyok	Land features, water-rights, water resources
Joe Gerlach	Geology and soils, mineral resources
Hugh Kendrick	Hydrology

Cadmus Group, Inc.

Ben Parkhurst	Aquatic resources
Sean Covington	Water quality, aquatic resources

Watts and Associates, Inc.

Gary Watts	Socioeconomics, recreation

Wyoming State Archaeologist's Office

Dave Eckles	Cultural and paleontological resources

6.3 SCOPING AND ISSUES IDENTIFICATION

6.3.1 BACKGROUND ON SCOPING AND PUBLIC PARTICIPATION

The scoping process for the Greybull Dam and Reservoir EIS was initiated in mid-September, 1994. A Notice of Intent to prepare an EIS was published in the Federal Register by the U.S. Army Corps of Engineers, Omaha, Nebraska, and 320 Scoping Notices were distributed by mail. Both actions solicited agency and public involvement in scoping. Comments on possible concerns and issues for EIS consideration were collected during an agency site tour, a public scoping meeting, an agency scoping meeting and by mail.

The Scoping Notice was mailed to interested Federal, State and local agencies; farmers, ranchers and landowners in the project vicinity; area, state and regional interest groups and organizations; local and

regional elected officials; and statewide and local media outlets. The Scoping Notice described the proposal, preliminarily identified issues and potential alternatives. It invited participation in a public scoping meeting in Emblem, Wyoming on October 26, 1994 and solicited written comments. The Notice asked that written comments be provided to the Corps in Omaha by November 9, 1994. Additionally, press releases encouraging public involvement in the process were issued to statewide and local media and paid advertisements were placed in the Casper Star Tribune and the Greybull Standard, a statewide and a local newspaper, respectively.

Interested Federal and State agencies were invited by the lead agencies to participate in a tour of the proposed site and three alternative locations on October 26, 1994. The agencies were also invited to participate in an agency scoping meeting on October 27, 1994 in Casper, Wyoming.

Twenty-five people participated in the site tours including representatives of the Corps from Cheyenne, Wyoming and Omaha, Nebraska, the BLM Worland District, the WGFD, the Wyoming State Engineer's Office (WSEO), the WDEQ-WQD, the WWDC, the WEST Consulting Team, the GVID and its consultants, SWWRC and GEI Consultants, Inc. At each site, potential structures and storage and conveyance facilities were described by consultants for the GVID. Tour participants made observations about environmental, topographical, and geological features, potential resource conflicts, and feasibility of each site to meet stated needs of the proponent.

The Public Scoping Meeting was held at the Emblem Gym from 7:00 to 9:30 p.m. on October 26. Sixty-three people registered at the meeting. Of those, 42 were members of the public and 21 were affiliated with state or Federal agencies or the WEST Consulting Team. Participants were provided copies of the Scoping Notice, a Fact Sheet on the proposal and potential issues, and an agenda for the evening. They were seated around clustered tables dividing the meeting into six small discussion groups. Maps showing the general area and location of each alternative and project information were provided at each table.

Brief presentations were made by the Corps, BLM, and WEST Consulting Team to the entire meeting about the proposal, potential alternatives, lead agency responsibilities, and NEPA process. Agency and Consulting Team personnel facilitated discussions in the small groups to learn about issues and concerns that people wished to see addressed by the EIS. Interaction among individuals within the groups helped identify different perspectives on similar concerns. Notes were taken in each group. As a final step in the process, each group reported back to the entire group about their discussion.

The Agency Scoping Meeting was held at 1:00 p.m. in the BLM Casper District office. Twenty-two people attended the agency meeting including representatives of WGFD, WSEO, USFWS, BOR, WWDC, Corps, BLM, and the WEST Consulting Team. The meeting format was similar to the public scoping meeting; however, the group was not divided and briefings were provided on what was discussed during the site tours and the public scoping meeting.

Eleven written comments were received by mail. One from an individual, two on behalf of organizations, five from Wyoming State agencies, and three from Federal agencies. Correspondence

received is available for review in the Project File (located at the BLM Worland District Office) along with the scoping mailing record, lists of participants in the agency meetings, and attendee lists from the public scoping meeting.

6.3.2 IDENTIFIED ISSUES AND SYNOPSIS OF COMMENTS

Following is a summary of issues and concerns organized by resource identified through the scoping process. A detailed scoping content analysis report was prepared following the scoping meetings and is available for review (project file). Most comments were made during the agency site tour or the public scoping meeting.

LAND FEATURES

• Are there unique land features, soil conditions, or geologic structures, and if so, are special structural and facility design considerations warranted?

• What is the potential for successful recontouring, revegetation, long-term stability, or returned agricultural productivity of borrow sites for each structural alternative?

WATER RESOURCES

Water Quality

• What are the potential effects of diversion dam, storage reservoir and facilities construction, maintenance, and operation on water quality and turbidity in the Greybull River, sediment transport in the Greybull and Bighorn rivers, and sediment deposition in Big Horn Lake?

• Can the Greybull River's Class 2 water quality standards and other applicable water quality standards be maintained during construction and operation?

• What are potential construction impacts to water quality associated with sediment generation from disturbed areas, equipment operation in streams, and hazardous materials handling from equipment refueling and maintenance?

•What is the potential for water quality compliance problems during construction, and are Federal regulations sometimes unrealistic?

• What are stream water quality effects of normal releases from storage reservoirs, of maintenance of diversion structure functional capacity, and of flows through outlet works and channels?

• How will sediment build-up behind diversion structures, in canals, and in the storage reservoir be managed and what are the environmental consequences?

• What is the potential for leaching of sulfate, salts, and selenium into reservoir water and what are the potential short-term and long-term risks to water quality and human health?

• Are there potential downstream water quality effects from pesticide use on irrigated lands?

• What are the effects on aquatic life and water quality from either partial dewatering or increased flows in affected reaches of the Greybull River?

• What are the effects on the quality of delivered water or on the quality of the increased return flows that result from additional irrigation?

• Would any aspect of the alternative expose fish or wildlife to hazardous substances and if so, how and what are the potential effects?

Wetland and Riparian Areas

• What is the quality, quantity and nature of wetlands which may be affected by the alternative? What are the anticipated impacts to wetlands from alternative construction and development and what is the potential for mitigation of adverse effects, opportunities for enhancement of area wetlands, and opportunities for creation of new wetland?

•What are the potential effects to wetland and riparian resources due to system operations or flow changes in the affected reaches of the Greybull River?

• What are the effects to wetland/riparian areas from flow fluctuations and to regeneration of willows and cottonwoods from a reduction in normal peak flows?

Water Management/Stream Flow Changes

• Are there changes in stream flows and if so, what are the effects on the fishery and other aquatic resources?

• To what extent would provision of minimum stream flows below the Sunshine reservoirs, or maintenance of a minimum reservoir pool affect the quantity and timeliness of deliverable water, system efficiency, and the fishery?

• Will reservoir operation allow exchanges of reservoir water with direct flow for upstream water rights?

• Will there be a minimum flow requirement below a new storage facility, and if so, would the WGFD pay for those minimum flows?

• Will minimum flow requirements below the Sunshine reservoirs' diversions prevent filling of upper reservoirs?

• Is there enough water available to fill the proposed reservoir?

• What are the effects of storage, diversion, flow, and use changes on water availability downstream including the lower Bighorn River and Big Horn Lake?

• What will be the effects on the riverine system during annual reservoir filling or due to any newly implemented diversions?

• What are the effects upon farm operations/crop production during project construction and implementation?

Supplemental Irrigation Water

• What would be the effects on supply and delivery of irrigation water for all users on the Greybull watershed?

• Are there any effects to existing water rights?

• What are the anticipated changes in cropping and irrigation practices, crop yields, and acres of irrigated lands?

• Is the demand for supplemental irrigation water constant year after year? How is this need currently being measured?

• What type of crops are being planted and harvested? What are the cropping practices?

• What are the current production rates? What will the anticipated production rates be after supplemental irrigation water is available?

• How many acres are currently being irrigated? Will the supplemental irrigation water create new irrigated lands? What type of irrigation practices are being used?

Conservation and Groundwater

• What is the estimated water loss from seepage and evaporation under the alternative?

AIR QUALITY

• Are there potential air quality effects from implementation of the alternatives?

NOISE

• What are the anticipated effects of construction noise on people and wildlife?

BIOLOGICAL RESOURCES

Threatened, Endangered, and Sensitive Species

• Are any threatened, endangered, or sensitive species or their habitats affected and if so, to what extent?

• Is the sturgeon chub present in the Greybull River or in the affected downstream portion of the Bighorn River? If so, what is its distribution and abundance and what would be the affects on the species of facilities construction and operation?

• Are prairie dogs, mountain plovers, raptors, or other species of interest or their habitats affected and how?

Aquatic Species

• How are fish and other aquatic species in the Greybull River affected by construction and operation under the alternative? What is the potential for development of a new warm water fishery? Are there anticipated effects on the lower Bighorn River and Big Horn Lake fisheries?

Terrestrial Species

• What are the potential effects to wildlife and waterfowl and their habitats? Are there impacts to big game migration and movement?

SOCIOECONOMIC

• What are the potential long-term net economic benefits of implementation of the alternative? What are the dollar costs of construction and increased annual cost to the GVID of system operation?

• What are the likely socioeconomic impacts of the construction workforce including housing, payrolls, transportation, and possible community concerns?

• Is hydropower generation feasible and if so, what are its costs and benefits?

• Is there adequate housing within easy commuting distance for the work force?

CULTURAL AND PALEONTOLOGICAL RESOURCES

• What are the potential effects to cultural and paleontological resources?

RECREATIONAL RESOURCES

• How are existing recreational opportunities affected and what is the potential for new or enhanced recreational opportunities under the alternative?

VISUAL/AESTHETICS

• To what degree are there changes in the visual appearance of the affected landscape and the general aesthetics of the project area?

PRIVATE PROPERTY

• What, if any, would be the effects to privately-owned property?

• Would it be feasible to provide for private livestock watering from canals?

• Would there be any effects on downstream water use or rights or on water rights between the diversion point and the accumulation of return flows?

DAM SAFETY

• What is the potential for structural failure due to earthquake, ground movement, or other geologic events, and what would be the likely downstream effects? What is the potential for seeping and piping and are there long-term maintenance/stability concerns at the location?

PURPOSE & NEED

• Would the alternative achieve the purpose and need of the project?

PROCESS

• Is it likely that facilities construction and operation could successfully be permitted under the alternative?

• Are previous efforts and studies being repeated and money wasted?

• Are the alternatives reasonable and feasible, do they address identified issues differently from the proposed action, and do they meet GVID's purpose and needs?

DESIGN

• Would implementation of the alternative result in single or multiple-use facility(ies) and if multiple, what would they be?

• Why is an off-channel reservoir proposed instead of one on the mainstream?

• What is proposed for lining the delivery canal?

• What type of pipe and canal are being proposed?

• What kind of road improvements, bridge access across the Greybull River, and other site access are proposed?

• How would outlet channels be protected downstream at Upper Sunshine, Rawhide, Blackstone, and Lower Roach Gulch?

RIGHTS-OF-WAY

• What will prevent the federal government from taking away the right-of-way in the future?

• Is it possible for GVID to purchase the necessary lands as opposed to obtaining a right-of-way?

• Are there effects to existing or potential new pipeline or utility lines?

6.3.3 AGENCY CORRESPONDENCE

Among comments received during the scoping process, the following letters from interested governmental agencies note concerns about compliance with statutes, regulations, or process. Copies of the agency letters are located in the project file.

Wyoming Game and Fish Department	11/04/94
Wyoming Game and Fish Department	10/31/94
Bureau of Reclamation	11/17/94
Wyoming Department of Environmental Quality	11/15/94
U.S. Environmental Protection Agency	11/15/94
U.S. Fish and Wildlife Service	10/28/94
Wyoming Department of Commerce State Parks and Historic Sites	09/26/94

6.4 CONSULTATION AND COORDINATION

Local, state, and federal agencies known to have regulatory or policy interests in the proponent's proposal have been invited by the lead agencies to participate in the NEPA process. In addition to the interagency consultation and coordination which occurred as part of the scoping process, the BLM and Corps have conducted consultation and coordination with interested and affected agencies regarding NEPA analysis, documentation, and statutory and regulatory compliance. These activities included reviews of an administrative draft of the DEIS, a June 21, 1995 meeting in Denver, Colorado, and a September 18, 1996 meeting in Casper. The Denver meeting included discussions on preliminary administrative drafts of Chapters 1 and 2, Purpose and Need and Alternatives development, approaches and schedules for completion of administrative drafts of Chapters 3 and 4, and overall process scheduling. Agencies attending that meeting included WWDC, Corps, BLM, WGFD, WDEQ WQD, and EPA. Also attending the meeting were the proponent, GVID; their consultants, SWWRC and GEI Consultants; and the WEST Consulting Team. All participating state and federal agencies were provided copies of the administrative DEIS for review. The Casper meeting included discussions regarding mitigation measures necessary to minimize or eliminate impacts identified in the analysis of project effects. The Casper meeting was attended by WWDC, Corps, GVID, and BLM, GVID, SWWRC, and the WEST Team.

The lead agencies and the WEST Consulting Team have also conferred with various local, state, and federal agencies to obtain data, seek input, and clarify concerns. More specifically, consultation has occurred with the USFWS and the WGFD regarding threatened, endangered and sensitive or candidate species; the Wyoming Office of Historic Preservation on potential cultural resources; local governments on infrastructure and public services capacities; the Corps planning and regulatory divisions regarding wetland effects and mitigation; the BLM on public lands and grazing issues; the WGFD regarding drainage-wide fisheries enhancements and terrestrial and avian wildlife; and others.

6.4.1 PARTICIPATING AGENCIES

The following agencies were provided copies of the DEIS for review and comment:

Federal Agencies

Federal Energy Regulatory Commission
National Advisory Council on Historic Preservation
U.S. Department of Agriculture
U.S. Department of Transportation
U.S. Department of the Army, Corps of Engineers
U.S. Department of Energy
U.S. Environmental Protection Agency - Region VIII
USDA Agricultural Stabilization & Conservation Service
USDA Farmers Home Administration
USDA Forest Service, Bighorn National Forest
USDA Forest Service, Rocky Mountain Region
USDA Forest Service, Shoshone National Forest
USDA Natural Resource Conservation Service
USDI Bureau of Indian Affairs
USDI Bureau of Land Management
USDI Bureau of Mines
USDI Bureau of Reclamation
USDI Geological Survey
USDI Fish and Wildlife Service
USDI National Park Service
USDI, Office of Environmental Policy & Compliance
USDOT, Federal Highway Administration

State Agencies

Office of the Governor
State of Wyoming DEQ/ Land Quality Division
State of Wyoming DEQ/Water Quality Division
State of Wyoming Office of Historical Preservation
Wyoming Department of Agriculture
Wyoming Department of Transportation
Wyoming Game & Fish Department
Wyoming Geological Survey
Wyoming Public Service Commission
Wyoming State Conservation Engineer
Wyoming State Planning Coordinator
Wyoming State Lands & Farm Loan Board
Wyoming State Engineer
Wyoming Water Development Commission

Local Agencies

Big Horn County Emergency Management
Big Horn County Planning & Zoning
Park County Planning
Town of Meeteetse
Town of Burlington

6.4.2 CONTRIBUTING INDIVIDUALS

The following list of persons contributed information to the preparation of the DEIS. Many of the individuals were contacted by phone and issues relevant to their expertise were discussed. Information obtained from these individuals and used in the DEIS is cited as a personal communication in the appropriate location in the text. The individuals are listed in alphabetical order.

Annear, Tom, Instream Flow Supervisor, Wyoming Game and Fish Department, Cody, Wyoming.

Anderson, Vic, States West Water Resources Corp., Cheyenne, Wyoming

Ames, Randy, Powell Hospital staff, Powell, Wyoming.

Bryant, Laurie, Paleontologist, Bureau of Land Management, Casper, Wyoming

Cooper, Craig, Division 3 Superintendent, Wyoming State Engineer's Office, Riverton, Wyoming

Craig, Lee, Big Horn County Conservation District, Greybull, Wyoming.

DiRienzo, Bill, Wetlands Program Supervisor, Wyoming Department of Environmental Quality, Cheyenne, Wyoming

Ebsen, Mike, Cooperative Programs Coordinator, Wyoming State Engineer's Office, Cheyenne, Wyoming

Edwards, Dave, Greybull Valley Irrigation District, Emblem, Wyoming

Fink, Kenneth, District Engineer, Wyoming Department of Transportation, Cody , Wyoming.

Henrichsen, Cameron, Range Conservationist, Bureau of Land Management, Worland, Wyoming

Hurley, Kevin, Biologist, Wyoming Game and Fish Department, Thermopolis, Wyoming.

Johnson, Tom, Project Manager, U.S. Army Corps of Engineers, Cheyenne, Wyoming
Julien, John, District Conservationist, Natural Resource Conservation Service, Cody, Wyoming.
Labado, Rebecca, Powell Hospital staff, Powell, Wyoming.
Lawrence, Barry, Director, Wyoming Water Resources Center, Laramie, Wyoming
Lindshield, Don, Western Sugar Company, Lovell, Wyoming.
Mischke, Dave, Holly Sugar Company, Worland, Wyoming
Mumper, Karen, Hydrologist, States West Water Resources Corporation, Cheyenne, Wyoming
Oakleaf, Bob, Non-game Coordinator, Wyoming Game and Fish Department, Lander, Wyoming.
O'Grady, Mike, Senior Hydrologist, States West Water Resources Corporation, Cheyenne, Wyoming
Raper, Charlie, Upper and Lower Sunshine Dam Operator, Greybull Valley irrigation District, Meeteetse, Wyoming
Roberts, Larry, Wildlife Biologist, Wyoming Game and Fish Department, Cheyenne, Wyoming.
Smith, Warren, Superintendent of the University of Wyoming Agricultural Field Station (retired), Powell, Wyoming.
Stevens, Tim, Biologist, Bighorn Basin Resource Area, Bureau of Land Management, Worland, Wyoming.
Tranas, Don, Natural Resource Conservation Service, Greybull, Wyoming.
Yekel, Steven, Fisheries Biologist, Wyoming Game and Fish Department, Cody, Wyoming.

6.4.3 ELECTED OFFICIALS, ORGANIZATIONS, BUSINESSES, AND NEWS MEDIA

The DEIS was provided to local and state elected officials, organizations and interest groups from lists compiled by the lead agencies or which indicated an interest during scoping, and to individuals or businesses providing comments or known to be interested. In addition to these lists, post cards announcing the availability of the DEIS were provided to approximately 180 addresses. Press releases announcing the availability of the DEIS, opportunities for public comment, and the length of the comment period were provided to local and Wyoming state-wide media.

<u>Elected Officials</u>

U.S. Senator Craig Thomas
U.S. Senator Alan K. Simpson
Congresswoman Barbara Cubin
Governor James Gerringer
State Senator Jerry Geis
State Representative Mike Baker
State Representative Henry Coe
State Representative John DeWitt
State Representative Sylvia Gams
State Representative Ray Harrison
State Representative Carroll Miller
State Representative Joe Reed
State Representative Peg Shreve
Big Horn County Commissioners
Park County Commissioners
Mayor Phil Juillard, Basin
Mayor John Landon, Meeteetse
Mayor Don Schlaf, Burlington
Mayor Ronald Wright, Greybull

<u>Organizations and Interest Groups</u>

Bench Canal Company
Big Horn County Conservation District
Big Horn County Library
Big Horn REA
Blackfeet Nation
Crow Tribal Council
Eastern Shoshone Tribal Council
Farmers Canal Company
Greater Yellowstone Coalition
Greybull Public Library
Greybull Valley Irrigation District
Izaak Walton League of America (Wyoming Division)
Jackson Hole Alliance
Lovell Library
Meeteetse Branch Library
Meeteetse Conservation District
Meeteetse Recreation District
National Audubon Society
National Outdoor Leadership School

Northern Arapaho Traditional Elders
Northern Arapaho Tribal Council
Park County Library
Powell Public Library
Public Lands Council
Shoshone & Arapaho Tribes, Office of Water Engineer
Sierra Club-Northern Plains Office
South Bighorn Basin, Multiple Use Association
South Big Horn Conservation District
State Board of Land Commission
The Nature Conservancy
Trout Unlimited, Chief Washakie Chapter
University of Wyoming - Department of Anthropology
University of Wyoming, Water Research Center
Washakie County Library
Willwood Irrigation District
Wind River Multiple Use Advocates
Wyoming Farm Bureau Federation
Wyoming Indian Affairs Council
Wyoming Natural Diversity Database
Wyoming Outdoor Council
Wyoming Trout Unlimited
Wyoming Wildlife Federation

Business Concerns

Banner & Associates
GEI Consultants, Inc.
L U Sheep Company
Marathon Oil Company
Pacific Power & Light Company
Pitchfork Ranch Company
Simpson Thacher & Bartlett
States West Water Resources Corporation
Western Sugar Company

Media Outlets Receiving News Releases

Associated Press
Basin Republican-Rustler
Billings Gazette
Casper Star Tribune
Cody Enterprise
Greybull Standard
KMMZ
KODI
KPOW
KTHE
KTVQ-TV
KTWO
KULR-TV
KWOR/KKLX
Land Use Chronicle
Lovell Chronicle
Northern Wyoming Daily News
Powell Tribune
Riverton Ranger
Thermopolis Independent Record
Wyoming Eagle/Tribune
Wyoming Livestock Roundup
Wyoming State Journal
Wyoming Stockman-Farmer

CHAPTER 7.0 REFERENCES, LITERATURE CITED AND GLOSSARY

7.1 REFERENCES AND LITERATURE CITED

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7.2 GLOSSARY

aggrading- the increase in elevation of stream beds and flood plains by the deposition of sediment eroded and transported from upstream areas.

alluvium - sediment deposited by flowing rivers, consisting primarily of sand and gravel.

armoring- a natural process whereby an erosion-resistant layer of relatively large particles is formed on a stream bed due to the removal of finer particles by streamflow. (b) Placement of a covering on a streambank, or channel bed to resist erosion.

animal unit month (AUM) - used to define the number of grazing livestock that a given tract of land can support; one AUM is the equivalent of one cow and one calf grazing for one month, or five sheep and five lambs grazing for the same time period.

aquifer - geologic stratum or zone that is saturated and provides water for wells and springs.

bank storage - water stored within a reservoir's or stream's banks. Water enters the soil when the reservoir or stream rises and drains out as the water level lowers. This effect can sometimes significantly increase a reservoir's storage capacity.

base flow - flow in a channel due to soil moisture release or groundwater discharge.

bed load - sediment that is transported in a stream by rolling, sliding, or skipping along the bed or very close to it.

braided stream - a stream whose flow is divided at normal stage by small mid-channel bars or small islands; the individual width of bars and islands is less than about three times the water width; a braided stream has the aspect of a single large channel within which are subordinate channels.

channel-forming flows - flow that fills a channel to bankfull levels, generally with a return period of approximately one year.

colluvial material - loose, incoherent material usually deposited by gravity, often at the foot of a cliff or steep slope.

conveyance loss - amount of water naturally lost, generally to evaporation or seepage, between two points along a water course.

Clean Water Act (CWA) - the Federal Water Pollutant Control Act of 1972, established to restore and maintain the physical, chemical and biological quality of waters in the United States.

daily discharge - volume of water passing through a channel averaged over one day.

degradation- lowering in elevation of stream beds and flood plains by material removal via scour.

effluent stream - stream that intersects the water table and receives flows due to groundwater discharge.

ephemeral stream - stream that usually dries out during protracted rainless periods, seldom flowing year long.

firm yield - the maximum quantity of water that can be guaranteed during a critical dry period.

HEC-RAS - Hydrologic Engineering Center - River Analysis System; a model developed for calculating water surface profiles for steady, gradually varied flow in a network of channels or a river or stream reach. HEC-RAS is most commonly used to estimate the degree of flooding that would result from a gievn flood flow in a river or stream.

hydric soil - soil that is saturated or flooded for a period long enough during the growing season to develop anaerobic conditions that promote the growth of hydrophytic vegetation.

hydrophytic vegetation - plants growing in water, very wet ground, or on a substrate that is at least periodically deficient of oxygen as a result of excessive water.

hypolimnion- the part of a reservoir below the thermocline consisting of stagnant water essentially uniform in temperature.

ichthyofauna - the fish life of a region

infiltration - movement of water from the surface into the soil.

lacustrine - of or pertaining to, or growing in lakes

lithic - of, relating to, or made of stone

macrophytes - a member of the macroscopic plant life especially pertaining to a body of water

National Environmental Policy Act (NEPA) - a 1970 legislative act passed to promote environmental improvement and protection.

Nephelometry Turbidity Units (NTU) - a type of turbidity test with measurement units based upon the amount of light scattered by suspended particles, versus amount of light absorbed by suspended particles.

palustrine - pertaining to swamps and marshes, and material deposited in a swamp environment.

periphytic - organisms that live attached to underwater surfaces

permeability - the ability of a rock type to allow the passage of fluid into or through it without impairing its structure; measured as the flow in volume through a unit cross-sectional area of a material in a given time period.

piping - the movement of soil particles by percolating water leading to the development of subsurface channels.

probable maximum flood (PMF) - the maximum runoff condition resulting from the most severe combination of hydrologic and meteorologic conditions that are considered reasonably possible for the drainage basin under study.

probable maximum precipitation (PMP) - a meteorologic estimate of the physical limit of rainfall intensity during a given period over a particular region.

recharge - water that infiltrates to an aquifer, usually from above.

recreation activity day - twelve (12) activity hours that may be accumulated continuously or simultaneously by one or more visitors

riparian - pertaining to anything connected with or adjacent to the banks of a stream.

sodium-adsorption ratio (SAR) - computed as the ratio of sodium concentrations (meq/l) to the square root of half the sum of calcium and magnesium concentrations (meq/l). If the ratio is substantially high, water infiltration rates through the soil may deteriorate due to formations of crusts that reduce soil permeability.

sediment - fragmental material transported, suspended or deposited by water.

sediment loading - weight or volume of sediment transported by a stream in a unit of time; discharge may be limited to certain sizes of sediment or to a specific part of the cross section.

seepage- the slow movement of water through small cracks and pores of porous geologic material.

seismic coefficient - a coefficient derived from the Modified Mercalli intensity scale for seismic activity that is used to estimate the potential seismic force that would be applied to a structure during a seismic event.

shear zone - a tabular zone of rock that has been crushed and brecciated by many parallel fractures due to shear strain.

subbituminous coal - coal with a calorific value between 8,300 and 10,500 BTUs per pound.

total dissolved solids (TDS) - the direct measurement of the weight of material per volume of water remaining after filtering out suspended solids larger than 10^{-5} µm, and evaporating off the water. Inorganic salts usually account for the majority of TDS in natural waters.

terrace - steplike land formations that are generally flat or gently sloping, bounded by a steep ascending slope on one side and a steep descending slope on the other side.

turbidity- the measurement of the degree to which suspended particles either absorb or reflect light.

total suspended solids (TSS) - the measurement in mg/l of the suspended fraction of organic and inorganic material in water, determined by filtering the water and drying and weighing the filtered material.

total suspended particles (TSP) - an air quality measurement of particulate matter within an air sample.

wetland - an area that is inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated oil conditions.

APPENDIX A

OPERATING PLAN FOR GREYBULL VALLEY IRRIGATION RESERVOIRS

Current Operating Plan - Upper and Lower Sunshine Reservoirs

Winter Operation (October through March)

Fill Priorities

1. Water from the Greybull River is diverted to fill Upper Sunshine Reservoir irrigation pool.
   - Upper Sunshine irrigation pool has the earliest priority water storage right (1928).
   - There is no current bypass requirement during the irrigation season except for higher priority downstream water rights.
   - Water is diverted during the fall before the inlet canal freezes and in the spring when it thaws.

2. Water from the Greybull River is diverted to fill Upper Sunshine Reservoir upper pool.
   - Upper Sunshine upper pool has the second earliest priority water storage right (1940).
   - There is no current bypass requirement during the irrigation season except for higher priority downstream water rights.
   - Water is diverted during the fall before the inlet canal freezes and in the spring when it thaws.

3. Water from the Wood River is diverted to fill Lower Sunshine Reservoir primary pool.
   - Lower Sunshine primary pool has the third earliest priority water storage right (1955).
   - Since the Wood River joins the Greybull River downstream of the Upper Sunshine diversion, Lower Sunshine can be filled at the same time as Upper Sunshine as long as there are no bypass requirements for earlier priority water rights.
   - Water requirements for higher priority water rights and for the Town of Meeteetse Pipeline (2.57 cfs) are bypassed. There is effectively no bypass requirement at the Wood River diversion outside of the irrigation season. *[Note: Return flows and inflows below the diversion, primarily from May Creek, are adequate to meet the Town of Meeteetse pipeline right most of the time. The town is also studying the possibility of extending the pipeline to Sunshine Creek below the Lower Sunshine Dam so that seepage from Lower Sunshine Dam can also be used to meet the Town water right.].*
   - Water is diverted during the fall before the inlet canal freezes and in the spring when it thaws.

4. Water from the Wood River is diverted to fill Lower Sunshine upper pool.
   - Lower Sunshine upper pool has the fourth earliest priority water storage right (1985).
   - Bypass requirements are the same as for the primary pool.
   - Water is diverted during fall before the inlet canal freezes and in the spring when it thaws.

5. Water from the Greybull River is diverted to fill Lower Sunshine storage pools via Upper Sunshine Reservoir.
   - Water can be released from Upper Sunshine to fill Lower Sunshine when both Upper Sunshine pools are full.
   - Water is diverted in fall before the inlet canal freezes and in the spring when it thaws.

Release Priorities

1. Water is released from Lower Sunshine first to meet downstream late fall irrigation demands if water is available.

2. Water is released from Upper Sunshine second to meet late fall irrigation demands. Attempts are made to retain enough water in Upper Sunshine to provide at least a minimal supply for the following year.

Summer Operation (April through September)

Fill Priorities

1. Water from the Greybull River is diverted to fill Upper Sunshine Reservoir irrigation pool.
   - Upper Sunshine irrigation pool has the earliest priority water storage right (1928), but it is relatively low in priority compared to water rights downstream.
   - Sufficient water is bypassed at the diversion (when added to bypasses at the Lower Sunshine diversion and downstream inflows) to maintain flow adequate to meet daily demands below the Greybull River at Meeteetse gage from higher priority water rights downstream.
   - Water is diverted after the inlet canal thaws in the spring.

2. Water from the Greybull River is diverted to fill Upper Sunshine Reservoir upper pool.
   - Upper Sunshine upper pool has the second earliest priority water storage right (1940).
   - Sufficient water is bypassed at the diversion (when added to bypasses at the Lower Sunshine diversion and downstream inflows) to maintain flow adequate to meet daily demands below the Greybull River at Meeteetse gage from higher priority water rights downstream.

3. Water from the Wood River is diverted to fill Lower Sunshine Reservoir primary pool.
   - Lower Sunshine primary pool has the third earliest priority water storage right (1955).
   - Lower Sunshine can be filled at the same time as Upper Sunshine since the Wood River joins the Greybull River downstream of the Upper Sunshine diversion.
   - Sufficient water is bypassed at the diversion (when added to bypasses at the Upper Sunshine diversion and downstream inflows) to maintain flow adequate to meet daily demands below the Greybull River at Meeteetse gage from higher priority water rights downstream.
   - Water is diverted in spring after the inlet canal thaws.

4. Water from the Wood River is diverted to fill Lower Sunshine Reservoir upper pool.
   - Lower Sunshine upper pool has the fourth earliest priority water storage right (1985).
   - Bypass requirements are the same as for the primary pool.

5. Water from the Greybull River is diverted to fill Lower Sunshine storage pools via Upper Sunshine Reservoir.
    - Water can be released from Upper Sunshine to fill Lower Sunshine when both Upper Sunshine pools are full.
    - Sufficient water is bypassed at the diversion (when added to bypasses at the Upper Sunshine diversion and downstream inflows) to maintain flow adequate to meet daily demands below the Greybull River at Meeteetse gage from higher priority water rights downstream.

Release Priorities

1. Water is released from Lower Sunshine upper pool first to meet downstream demands.
    - Shortages generally occur first in April when irrigation has begun but snowmelt runoff has not peaked.
    - Releases may not be possible because of icing in the channel of Sunshine Creek and in the outlet works of Lower Sunshine reservoir.
    - Shortages also occur during the late irrigation season when snowmelt runoff is past its peak and there is insufficient natural flow to meet irrigation demand.

2. Water is released from Lower Sunshine primary pool second to meet downstream demands.

3. Water is released from Upper Sunshine upper pool third to meet downstream demands.

4. Water is released from Upper Sunshine irrigation pool fourth to meet downstream demands.

Future Operating Plan - with a Lower Valley Reservoir

<u>Winter Operation (October through March)</u>

Fill Priorities

1-5. Fill priorities 1-5 would remain the same as under current conditions (see above).

6. Water would be diverted from the Greybull River to fill the lower valley reservoir.
    - The lower valley reservoir would have the fifth earliest priority water storage right.
    - Sufficient water would be bypassed to meet requirements of:
        1. Downstream water rights of higher priority;
        2. Minimum flow of 50 cfs below diversion; or
        3. Natural flow if natural flow is less than 50 cfs.
    - The lower valley reservoir could be filled at the same time as Upper and Lower Sunshine as long as bypasses are sufficient to meet downstream requirements.
    - Water would be diverted in fall before the inlet canal freezes and in the spring when it thaws.

Release Priorities

1. Water would be released from the lower valley reservoir first to meet downstream late fall irrigation demands if water is available.

2. Water would be released from Lower Sunshine second to meet downstream late fall irrigation demands if water is available.

3. Water would be released from Upper Sunshine third to meet late fall irrigation demands. An attempt would be made to retain enough water in Upper Sunshine to provide at least a minimal supply for the following year.

<u>Summer Operation (April through September)</u>

Fill Priorities

1. Water from the Greybull River would be diverted to fill Upper Sunshine irrigation pool.
   - Upper Sunshine irrigation pool has the earliest priority water storage right (1928), but it is relatively low in priority compared to water rights downstream.
   - Sufficient water would be bypassed at the diversion (when added to bypasses at the Lower Sunshine reservoir diversion and the lower valley reservoir diversion) to maintain flow adequate to meet daily demands below the lower valley reservoir diversion from higher priority water rights downstream.
   - Water would be diverted after the inlet canal thaws in the spring.

2. Water from the Greybull River would be diverted to fill Upper Sunshine upper pool.
   - Upper Sunshine upper pool has the second earliest priority water storage right (1940).
   - Sufficient water would be bypassed at the diversion (when added to bypasses at the Lower Sunshine reservoir diversion and the lower valley reservoir diversion) to maintain flow adequate to meet daily demands below the lower valley reservoir diversion from higher priority water rights downstream.

3. Water from the Wood River would be diverted to fill Lower Sunshine primary pool.
   - Lower Sunshine primary pool has the third earliest priority water storage right (1955).
   - Lower Sunshine could be filled at the same time as Upper Sunshine since the Wood River joins the Greybull River downstream of the Upper Sunshine diversion.
   - Sufficient water would be bypassed at the diversion (when added to bypasses at the Lower Sunshine Reservoir diversion and the lower valley reservoir diversion) to maintain flow adequate to meet daily demands below the lower valley reservoir diversion from higher priority water rights downstream.
   - Water would be diverted in spring after the inlet canal thaws.

4. Water from the Wood River would be diverted to fill Lower Sunshine upper pool.
   - Lower Sunshine upper pool has the fourth earliest priority water storage right (1985)
   - Bypass requirements would be the same as for the primary pool

5. Water from the Greybull River would be diverted to fill Lower Sunshine storage pools via Upper Sunshine Reservoir.
   - Water could be released from Upper Sunshine to fill Lower Sunshine when both Upper Sunshine pools are full.
   - Sufficient water would be bypassed at the diversion (when added to bypasses at the Lower Sunshine reservoir diversion and the lower valley reservoir diversion) to maintain flow adequate to meet daily demands below the lower valley reservoir diversion from higher priority water rights downstream.

6. Water from the Greybull River would be diverted to fill the lower valley reservoir.
   - The lower valley reservoir would have the fifth earliest priority water storage right.
   - Sufficient water would be bypassed to meet requirements of:
     1. Downstream water rights of higher priority; or
     2. Natural flow if natural flow is less than downstream demand.
   - The lower valley reservoir could be filled at the same time as Upper and Lower Sunshine as long as bypasses are sufficient to meet downstream requirements.
   - The lower valley reservoir may divert and release water on a daily basis to reregulate daily peaks in flow and level flows downstream of the diversion.

Release Priorities

1. Water would be released from the lower valley reservoir first to meet downstream irrigation demands or as exchange water for upstream shareholders diverting out of priority.
   - Releases would be made in April to meet demands that cannot be met by upstream reservoirs.

2. Water would be released from Lower Sunshine upper pool second to meet downstream demands.
   - Shortages met by upper valley reservoirs would generally occur during the late irrigation season when snowmelt runoff is past its peak, there is insufficient natural flow to meet irrigation demand, and the lower valley reservoir is depleted.

3. Water would be released from Lower Sunshine primary pool third to meet downstream demands.

4. Water would be released from Upper Sunshine upper pool fourth to meet downstream demands.

5. Water would be released from Upper Sunshine irrigation pool fifth to meet downstream demands.
   - An attempts would be made to maintain enough storage in Upper Sunshine to provide at least a minimal supply for the following year.

APPENDIX B

SPECIES LISTS AND SCIENTIFIC NAMES

Dominant Plant Species by Community of the Lower Roach Gulch Alternative

Plant Community	Species Present	Scientific Name
mixed grassland-sagebrush shrubland	big sagebrush	*Artemisia tridentata*
	silver sagebrush	*Artemisia cana*
	bluebunch wheatgrass	*Agropyron spicatum*
	Indian ricegrass	*Oryzopsis hymenoides*
	needle-and-thread	*Stipa comata*
	cheatgrass	*Bromus tectorum*
	blue grama	*Bouteloua gracilis*
	smooth brome	*Bromus inermis*
	prairie junegrass	*Koeleria cristata*
	crested wheatgrass	*Agropyron cristatum*
	western wheatgrass	*Agropyron smithii*
	squirreltail	*Sitanion hystrix*
	western needlegrass	*Stipa occidentalis*
	annual false wheatgrass	*Eremopyrum triticeum*
	basin wild rye	*Elymus cinereus*
	tall fescue	*Festuca arundinacea*
	broom snakeweed	*Gutierrezia sarothrae*
	curlycup gumweed	*Grindelia squarrosa*
	pricklypear	*Opuntia polycantha*
	buckwheat	*Eriogonum spp.*
	saltbush	*Atriplex sp.*
	aster	*Aster spp.*
	greasewood	*Sarcobatus vermiculatus*
	alkali sacaton	*Sporobolus aeroides*
	green rabbitbrush	*Chrysothamnus viscidiflorus*
	darnel	*Lolium sp.*
willow riparian shrub	sandbar willow	*Salix exigua*
	wild licorice	*Glycyrrhiza lepidota*
	clover	*Trifolium sp.*
	dandelion	*Taraxacum officinale*
	Canada thistle	*Cirsium arvense*
	smooth scouringrush	*Equisetum laevigatum*
	narrowleaf cottonwood	*Populus angustifolia*
	wild rose	*Rosa woodsii*
	white-blossom sweetclover	*Melilotus albus*
	Olney's bulrush	*Scirpus americanus*
	creeping spikerush	*Eleocharis palustris*

Dominant Plant Species by Community of the Lower Roach Gulch Alternative

Plant Community	Species Present	Scientific Name
mixed riparian shrub-shrub steppe	baltic rush	*Juncus balticus*
	three-square bulrush	*Scirpus pungens*
	alkali cordgrass	*Spartina gracilis*
	cheatgrass	*Bromus tectorum*
	intermediate wheatgrass	*Agropyron intermedium*
	foxtail barley	*Hordeum jubatum*
	inland saltgrass	*Distichlis spicata*
	sandbar willow	*Salix exigua*
	Russian thistle	*Salsola kali*
	common cocklebur	*Xanthium strumarium*
	narrowleaf cottonwood	*Populus angustifolia*
	wild licorice	*Glycyrrhiza lepidota*
	tamarisk	*Tamarix chinensis*
palustrine wetland	foxtail barley	*Hordeum jubatum*
	sandbar willow	*Salix exigua*
	tamarisk	*Tamarix chinensis*
	plains cottonwood	*Populus deltoides*
	narrowleaf cottonwood	*Populus angustifolia*
	Canada thistle	*Cirsium arvense*
	cocklebur	*Xanthium strumarium*
	Kentucky bluegrass	*Poa pratensis*
	beaked sedge	*Carex rostrata*
	Nebraska sedge	*Carex nebraskensis*
	white clover	*Trifolium repens*
	alkali cordgrass	*Spartina gracilis*
	softstem bulrush	*Scirpus validus*
	inland saltgrass	*Distichlis spicata*

Dominant Plant Species by Community of the Lower Roach Gulch Alternative

Plant Community	Species Present	Scientific Name
cottonwood riparian	cattail	*Typha latifolia*
	Nebraska sedge	*Carex nebraskensis*
	foxtail barley	*Hordeum jubatum*
	smooth scouringrush	*Equisetum laevigatum*
	baltic rush	*Juncus balticus*
	sandbar willow	*Salix exigua*
	rabbitfoot grass	*Polypogon monspeliensis*
	softstem bulrush	*Scirpus validus*
	three-square bulrush	*Scirpus pungens*
	canary reedgrass	*Phalaris arundinaceus*
	rough bugleweed	*Lycopus asper*
	wild licorice	*Glycyrrhiza lepidota*
	clover	*Trifolium sp.*
	dandelion	*Taraxacum officinale*
	Canada thistle	*Cirsium arvense*
	narrowleaf cottonwood	*Populus angustifolia*
	wild rose	*Rosa woodsii*
	white sweetclover	*Melilotus alba*
	yellow sweetclover	*Melilotus officinale*
	duckweed	*Lemna minor*
	fowl bluegrass	*Poa palustris*
	barnyard grass	*Echinochloa muricata*
	timothy	*Phleum pratense*
	musk thistle	*Carduus nutans*
	wheatgrass	*Agropyron sp.*
	smooth brome	*Bromus inermis*
	plantain	*Plantago sp.*
	Russian olive	*Eleagnus angustifolia*
	juniper	*Juniperus sp.*
	golden currant	*Ribes acreum*

Dominant Plant Species by Community for the Blackstone Gulch Alternative.

Plant Community	Species Present	Scientific Name
mixed grassland-sagebrush shrubland	big sagebrush	*Artemisia tridentata*
	green rabbitbrush	*Chrysothamnus viscidiflorus*
	linear-leaved rabbitbrush	*Chrysothamnus lanceolatus*
	blue grama	*Bouteloua gracilis*
	crested wheatgrass	*Agropyron cristatum*
	western wheatgrass	*Agropyron smithii*
	squirreltail	*Sitanion hystrix*
	western needlegrass	*Stipa occidentalis*
	annual false wheatgrass	*Eremopyrum triticeum*
	basin wild rye	*Elymus cinereus*
	tall fescue	*Festuca arundinacea*
	Indian ricegrass	*Oryzopsis hymenoides*
	cheatgrass	*Bromus tectorum*
	needle-and-thread	*Stipa comata*
	prickly-pear	*Opuntia polycantha*
	fringed sagebrush	*Artemisia frigida*
	common cocklebur	*Xanthium strumarium*
	darnel	*Lolium sp.*
mixed riparian shrub-shrub steppe	sandbar willow	*Salix exigua*
	plains cottonwood	*Populus deltoides*
	narrowleaf cottonwood	*Populus angustifolia*
	tamarisk	*Tamarix chinensis*
	foxtail barley	*Hordeum jubatum*
	Canada thistle	*Cirsium arvense*
	silver sagebrush	*Artemisia cana*
	wild rose	*Rosa woodsii*
	intermediate wheatgrass	*Agropyron intermedium*
	cheatgrass	*Bromus tectorum*
	Russian thistle	*Salsola kali*
	common cocklebur	*Xanthium strumarium*
	wild licorice	*Glycyrrhiza lepidota*
willow riparian shrub	sandbar willow	*Salix exigua*
	baltic rush	*Juncus balticus*
	barnyardgrass	*Echinochloa muricata*

Dominant Plant Species by Community for the Blackstone Gulch Alternative.

Plant Community	Species Present	Scientific Name
cottonwood riparian	cattail	*Typha latifolia*
	Nebraska sedge	*Carex nebraskensis*
	foxtail barley	*Hordeum jubatum*
	smooth scouringrush	*Equisetum laevigatum*
	baltic rush	*Juncus balticus*
	sandbar willow	*Salix exigua*
	rabbitfoot grass	*Polypogon monspeliensis*
	softstem bulrush	*Scirpus validus*
	three-square bulrush	*Scirpus pungens*
	canary reedgrass	*Phalaris arundinaceus*
	rough bugleweed	*Lycopus asper*
	wild licorice	*Glycyrrhiza lepidota*
	clover	*Trifolium sp.*
	dandelion	*Taraxacum officinale*
	Canada thistle	*Cirsium arvense*
	narrowleaf cottonwood	*Populus angustifolia*
	wild rose	*Rosa woodsii*
	white sweetclover	*Melilotus alba*
	yellow sweetclover	*Melilotus officinale*
	duckweed	*Lemna minor*
	fowl bluegrass	*Poa palustris*
	barnyard grass	*Echinochloa muricata*
	timothy	*Phleum pratense*
	musk thistle	*Carduus nutans*
	wheatgrass	*Agropyron sp.*
	smooth brome	*Bromus inermis*
	plantain	*Plantago sp.*
	Russian olive	*Eleagnus angustifolia*
	juniper	*Juniperus sp.*

Dominant Plant Species by Community for the Blackstone Gulch Alternative.

Plant Community	Species Present	Scientific Name
palustrine wetland	foxtail barley	*Hordeum jubatum*
	smooth brome	*Bromus inermis*
	fowl bluegrass	*Poa palustris*
	Kentucky bluegrass	*Poa pratensis*
	crested wheatgrass	*Agropyron cristatum*
	inland saltgrass	*Distichlis spicata*
	baltic rush	*Juncus balticus*
	three-square bulrush	*Scirpus pungens*
	softstem bulrush	*Scirpus validus*
	Nebraska sedge	*Carex nebraskensis*
	linear-leaved rabbitbrush	*Chrysothamnus lanceolatus*
	sandbar willow	*Salix exigua*
	plains cottonwood	*Populus deltoides*
	wild rose	*Rosa woodsii*
	Canada thistle	*Cirsium arvense*
	cocklebur	*Xanthium strumarium*

Mammals Potentially Occuring in the Project Areas

Species	Scientific Name	Habitat	Expected[1] Occurrence
masked shrew	*Sorex cinereus*	mixed	B
dwarf shrew	*Sorex nanus*	mixed	B
water shrew	*Sorex palustris*	riparian	B
Merriam's shrew	*Sorex merriami*	mixed	B
vagrant shrew	*Sorex vagrans*	riparian	B
California bat	*Myotis californicus*	mixed	U
small-footed myotis	*Myotis ciliolabrum*	mixed	B
Yuma myotis	*Myotis yumanensis*	shrubland	U
little brown myotis	*Myotis lucifugus*	mixed	B
long-legged myotis	*Myotis volans*	mixed	U
long eared myotis	*Myotis evotis*	mixed	B
silver-haired bat	*Lasionycteris noctivagans*	riparian	U
big brown bat	*Eptesicus fuscus*	mixed	U
hoary bat	*Lasiurus cinereus*	mixed	U
spotted bat	*Euderma maculatum*	shrubland	B
Townsend's big-eared bat	*Plecotus townsendii*	mixed	B
Nuttall's cottontail	*Sylvilagus nutallii*	riparian	B
desert cottontail[2]	*Sylvilagus audubonii*	mixed	B
white-tailed jackrabbit	*Lepus townsendii*	shrubland	B
least chipmunk[2]	*Sciurus minimus*	mixed	B
yellow-bellied marmot	*Marmota flaviventris*	rocky areas	B
thirteen-lined ground squirrel	*Spermophilus tridecimlineatus*	shrubland	B
black-tailed prairie dog	*Cynomys ludovicianus*	grassland	B
white-tailed prairie dog	*Cynomys leucurus*	shrubland	B
fox squirrel	*Sciurus niger*	riparian	B
red squirrel	*Tamiasciurus hudsonicus*	riparian	B
Northern pocket gopher[2]	*Thomomys talpoides*	mixed	B
olive-backed pocket mouse	*Perognathus fusciatus*	shrubland	B
Ord's kangaroo rat	*Dipodomys ordii*	shrubland	B
beaver[2]	*Castor canadensis*	riparian	B
western harvest mouse	*Reithrodontomys megalotis*	mixed	B
deer mouse	*Peromyscus maniculatus*	mixed	B
northern grasshopper mouse	*Onychomys leucogaster*	shrubland	B

[1] Expected occurrence: B=breeding resident; U=uncertain status; H=historical record

[2] Species or evidence of species observed in project area during WEST site visits

Mammals Potentially Occuring in the Project Areas

Species	Scientific Name	Habitat	Expected[1] Occurrence
bushy-tailed woodrat[2]	*Neotoma cinerea*	rocky areas	B
heather vole	*Phenacomys intermedius*	mixed	B
meadow vole	*Microtus pennsylvanicus*	mixed	B
montane vole	*Microtus montanus*	mixed	B
long-tailed vole	*Microtus longicaudus*	mixed	B
southern red-backed vole	*Clethrionomys gapperi*	mixed	B
prairie vole	*Microtus ochrogaster*	shrubland	B
sagebrush vole	*Lemmiscus curtatus*	shrubland	B
muskrat	*Ondatra zibethicus*	riparian	B
Western jumping mouse	*Zappus princeps*	riparian	B
porcupine	*Erithizon dorsatum*	mixed	B
gray wolf	*Canis lupus*	mixed	H
coyote[2]	*Canis latrans*	mixed	B
red fox	*Vulpes vulpes*	mixed	B
black bear	*Ursus americanus*	mixed	B
raccoon[2]	*Procyon lotor*	riparian	B
marten	*Martes americana*	riparian	B
ermine	*Mustela erminea*	mixed	B
long-tailed weasel	*Mustela frenata*	mixed	B
mink	*Mustela vison*	riparian	B
black-footed ferret	*Mustela nigripes*	prairie dog colonies	H
badger[2]	*Taxidea taxus*	shrubland	B
western spotted skunk	*Spilogale gracilis*	shrubland	B
striped skunk[2]	*Mephitis mephitis*	mixed	B
river otter	*Lutra canadensis*	riparian	B
mountain lion	*Felis concolor*	mixed	B
bobcat[2]	*Lynx rufus*	mixed	B
pronghorn[2]	*Antilocapra americana*	shrubland	B
mule deer[2]	*Odocoileus hemionas*	mixed	B
white-tailed deer[2]	*Odocoileus virginianus*	riparian	B
elk	*Cervus elaphus*	mixed	B
moose[2]	*Alces alces*	riparian	B
wild horse	*Equus caballus*	mixed	U

[1] Expected occurrence: B=breeding resident; U=uncertain status; H=historical record

[2] Species or evidence of species observed in project area during WEST site visits

Birds Potentially Occuring in the Project Areas

Species	Scientific Name	Habitat	Expected[1] Occurrence
common loon	*Gavia immmer*	lakes	M
eared grebe	*Podiceps nigricolis*	lakes, ponds	B
pied-billed grebe	*Podilymbus podiceps*	lakes, ponds	W,M
western grebe	*Aechmophorus occidentalis*	lakes, ponds	M
white pelican	*Pelicanus erythrorhynchos*	lakes, ponds	M
double-crested cormorant	*Phalacrocorax auritus*	river	B
great blue heron[2]	*Ardea herodius*	wetland, riparian	B
great egret	*Casmerodius albus*	wetland, riparian	M
snowy egret	*Egretta thula*	marshes	M
cattle egret	*Bubulcus ibis*	agriculture	M
green-backed heron	*Butorides striatus*	wetland	M
black-crowned night heron	*Nycticorax nycticorax*	wetland	M
white-faced ibis	*Plegadis chihi*	marshes	B
tundra swan	*Cygnus columbianus*	lakes, rivers	M
trumpeter swan	*Cygnus buccinator*	lakes, rivers	M
greater white-fronted goose	*Anser albifrons*	marshes, lakes	M
snow goose	*Chen caerulescens*	lakes, agriculture	M
Canada goose[2]	*Branta canadensis*	mixed, water	B
wood duck[2]	*Aix sponsa*	riparian	B
mallard[2]	*Anas platyrhynchos*	mixed, water	B
green-winged teal[2]	*Anas crecca*	marshes, lakes	B
northern pintail	*Anas acuta*	marshes, lakes	B
blue-winged teal[2]	*Anas discors*	marshes, lakes	B
cinnamon teal	*Anas cyanoptera*	marshes, lakes	B
northern shoveler[2]	*Anas clypeata*	marshes, lakes	B
gadwall	*Anas strepera*	marshes, lakes	B
American widgeon	*Anas americana*	marshes, lakes	B
canvasback	*Aythya valisineria*	marshes, lakes	B
redhead	*Aythya americana*	marshes, lakes	B
ring-necked duck	*Aythya collaris*	marshes, lakes	B
lesser scaup	*Aythya affinis*	marshes, lakes	B
greater scaup	*Aythya marila*	marshes. lakes	M
common goldeneye	*Buchephala clangula*	marshes, lakes	B
Barrow's goldeneye	*Buchephala islandica*	marshes, lakes	B
bufflehead	*Buchephala albeola*	marshes, lakes	B
common merganser[2]	*Mergus merganser*	rivers, lakes	B
red-breasted merganser	*Mergus serrator*	rivers, lakes	U
hooded merganser	*Lophodytes cucullatus*	rivers, lakes	M

[1] Expected occurrence: B=breeding resident; M=migrant or occassional visitor through area; W=winter resident; U=uncertain status; H=historical record

[2] Species or evidence of species observed in project area during WEST site visits

Birds Potentially Occuring in the Project Areas

Species	Scientific Name	Habitat	Expected[1] Occurrence
ruddy duck	*Oxyura jamaicensis*	marshes, lakes	B
turkey vulture	*Cathartes aura*	mixed	B
osprey	*Pandion haliaetus*	rivers, lakes	B
bald eagle	*Haliaeetus leucocephalus*	mixed	B
northern harrier	*Circus cyaneus*	shrubland	B
sharp-shinned hawk	*Accipiter striatus*	riparian	B
Cooper's hawk[2]	*Accipiter cooperi*	riparian	B
northern goshawk	*Accipiter gentilis*	riparian	M
broad-winged hawk	*Buteo platypterus*	agriculture	M
Swainson's hawk	*Buteo swainsoni*	mixed	B
red-tailed hawk[2]	*Buteo jamaicensis*	mixed	B
ferruginous hawk	*Buteo regalis*	shrubland	B
rough-legged hawk	*Buteo lagopus*	shrubland	M,W
golden eagle[2]	*Aquila chrysaetos*	mixed	B
American kestrel[2]	*Falco sparverius*	mixed	B
merlin	*Falco columbarius*	mixed	B
prairie falcon[2]	*Falco mexicanus*	shrubland	B
peregrine falcon	*Falco peregrinus*	mixed, cliffs	M
gyrfalcon	*Falco rusticolus*	shrubland	M,W
barn owl	*Tyto alba*	mixed	B
eastern screech owl	*Otus asio*	riparian	B
western screech owl	*Otus kennicottii*	riparian	B
great horned owl[2]	*Bubo virginianus*	mixed	B
burrowing owl	*Speotyto cunicularia*	shrubland	B
long-eared owl	*Asio otus*	mixed	B
short-eared owl	*Asio flammeus*	shrubland	B
northern saw-whet owl	*Aegolius acadicus*	riparian	B
snowy owl	*Nyctea scandiaca*	shrubland	M,W
sage grouse[2]	*Centrocercus urophasianus*	shrubland	B
ring-necked pheasant[2]	*Phasianus colchicus*	riparian	B
chukar	*Alectoris chukar*	shrubland, rocks	B
gray partridge[2]	*Perdix perdix*	riparian	B
wild turkey	*Meleagris gallopovo*	riparian	B
sora	*Porzana carolina*	marshes	B
American coot	*Fulica americana*	marshes	B
sandhill crane[2]	*Grus canadensis*	marshes, wet meadows	B
killdeer[2]	*Charadrius vociferus*	river, ponds	B
mountain plover	*Charadrius montanus*	shortgrass prairie	B
black-necked stilt	*Himantopus mexicanus*	marshes, ponds	B

[1] Expected occurrence: B=breeding resident; M=migrant or occassional visitor through area; W=winter resident; U=uncertain status; H=historical record

[2] Species or evidence of species observed in project area during WEST site visits

Birds Potentially Occuring in the Project Areas

Species	Scientific Name	Habitat	Expected[1] Occurrence
American avocet	*Recurvirostra americana*	marshes, ponds	B
willet	*Catoptrophorus semipalmatus*	marshes, ponds	B
spotted sandpiper[2]	*Actitis macularia*	river, ponds	B
upland sandpiper	*Bartramia longicauda*	agriculture	B
long-billed curlew	*Numenius americanus*	agriculture	B
common snipe[2]	*Gallinago gallinago*	marshes, wet meadows	B
Wilson's phalarope	*Phalaropus tricolor*	ponds, lakes	B
red-necked phalarope	*Phalaropus lobatus*	marshes, lakes	M
Franklin's gull	*Larus pipixcan*	marshes, lakes	B
Bonaparte's gull	*Larus philadelphia*	marshes, lakes	M
ring-billed gull	*Larus delawarensis*	marshes, lakes	B
California gull	*Larus californicus*	mixed	B
caspian tern	*Sterna caspia*	marshes, lakes	B
Forster's tern	*Sterna forsteri*	marshes, lakes	B
common tern	*Sterna hirundo*	marshes, lakes	M
black tern	*Chlidonias niger*	marshes, lakes	B
black-bellied plover	*Pluvialis squatarola*	agriculture, mixed	M
lesser golden plover	*Pluvialis dominica*	agriculture, mixed	M
semipalmated plover	*Charadrius semipalmatus*	shorelines	M
greater yellowlegs	*Tringa melanoleuca*	shorelines	M
lesser yellowlegs	*Tringa flavipes*	shorelines	M
solitary sandpiper	*Tringa solitaria*	shorelines	M
whimbrel	*Numenius phaeopus*	marsh, shorelines	M
marbled godwit	*Limosa fedora*	marsh, shorelines	M
ruddy turnstone	*Arenaria interpres*	shorelines	M
red knot	*Calidris canutus*	shorelines	M
sanderling	*Calidris alba*	shorelines	M
semipalmated sandpiper	*Calidris pusilla*	shorelines	M
western sandpiper	*Calidris mauri*	shorelines	M
least sandpiper	*Calidris minutilla*	shorelines	M
white-rumped sandpiper	*Calidris fuscicollis*	shorelines	M
Baird's sandpiper	*Calidris bairdii*	shorelines	M
pectoral sandpiper	*Calidris melanotus*	shorelines	M
dunlin	*Caladris alpina*	shorelines	M
stilt sandpiper	*Calidris himantopus*	shorelines	M
long-billed dowitcher	*Limnodromus scolopaceus*	shorelines	M
rock dove[2]	*Columba livia*	mixed	B
mourning dove[2]	*Zenaida macroura*	mixed	B
black-billed cuckoo	*Coccyzus erythropthalmus*	riparian	B

[1] Expected occurrence: B=breeding resident; M=migrant or occassional visitor through area; W=winter resident; U=uncertain status; H=historical record

[2] Species or evidence of species observed in project area during WEST site visits

Birds Potentially Occuring in the Project Areas

Species	Scientific Name	Habitat	Expected[1] Occurrence
yellow-billed cuckoo	*Coccyzus erythropthalmus*	riparian	B
common nighthawk[2]	*Chordeiles minor*	shrubland	B
common poorwill	*Phalaenoptilus nuttallii*	shrubland	B
white-throated swift[2]	*Aeronautes sexatalis*	mixed, cliffs	B
calliope hummingbird	*Stellula calliope*	riparian	M
broad-tailed hummingbird	*Selasphorus platycercus*	riparian	M
rufous hummingbird	*Selasphorus rufus*	riparian	M
belted kingfisher[2]	*Ceryle alcyon*	riparian	B
Lewis' woodpecker	*Melanerpes lewis*	riparian	B
red-headed woodpecker	*Melanerpes erythrocephalus*	riparian	B
downy woodpecker[2]	*Picoides pubescens*	riparian	B
hairy woodpecker	*Picoides villosus*	riparian	B
northern flicker[2]	*Colaptes auratus*	riparian	B
western wood pewee[2]	*Contopus sordidulus*	riparian	B
willow flycatcher	*Empidonax trailii*	riparian	B
least flycatcher[2]	*Empidonax minimus*	riparian	B
dusky flycatcher	*Empidonax oberholseri*	riparian	B
Say's phoebe[2]	*Sayornis saya*	shrubland	B
western kingbird	*Tyrannus verticalis*	shrubland	B
eastern kingbird[2]	*Tyrannus tyrannus*	shrubland	B
horned lark	*Eromophila alpestris*	grassland	B
tree swallow[2]	*Tachycineta bicolor*	riparian	B
violet-green swallow[2]	*Tachycineta thalassina*	riparian	B
northern rough-winged swallow[2]	*Stelgidopteryx serripennis*	mixed	B
bank swallow[2]	*Riparia riparia*	mixed	B
cliff swallow[2]	*Hirundo pyrrhonota*	mixed	B
barn swallow[2]	*Hirundo rustica*	mixed	B
Stellar's jay	*Cyanocitta stelleri*	riparian	B
blue jay	*Cyanocitta cristata*	riparian	B
pinyon jay	*Gymnorhinus cyanocephalus*	shrubland	B
Clark's nutcracker	*Nucifraga columbiana*	badlands	B
black-billed magpie[2]	*Pica pic*	mixed	B
American crow[2]	*Corvus brachyrhynchos*	mixed	B
common raven[2]	*Corvus corax*	mixed	B
black-capped chickadee[2]	*Parus atricapillus*	riparian	B
mountain chickadee	*Parus gambeli*	riparian	B
red-breasted nuthatch	*Sitta canadensis*	riparian	B
white-breasted nuthatch[2]	*Sitta carolinensis*	riparian	B
brown creeper	*Certhia americana*	riparian	M,W

[1] Expected occurrence: B=breeding resident; M=migrant or occassional visitor through area; W=winter resident; U=uncertain status; H=historical record

[2] Species or evidence of species observed in project area during WEST site visits

Birds Potentially Occuring in the Project Areas

Species	Scientific Name	Habitat	Expected[1] Occurrence
rock wren[2]	*Salpinctes obsoletus*	shrubland, rock	B
canyon wren	*Catherpes mexicanus*	badland	B
house wren[2]	*Troglodytes aedon*	riparian	B
winter wren	*Troglodytes troglodytes*	riparian	M
marsh wren	*Cistothorus palustris*	wetland	B
golden-crowned kinglet	*Regulus satrapa*	riparian	M,W
ruby-crowned kinglet[2]	*Regulus calendula*	riparian	B
western bluebird	*Sialia mexicana*	mixed	M
mountain bluebird[2]	*Siala curricoides*	shrubland	B
Townsend's solitaire	*Myadestes townsendi*	riparian	M
veery	*Catharus fuscescens*	riparian	B
Swainson's thrush[2]	*Catharus ustulatus*	riparian	B
hermit thrush	*Catharus guttatus*	riparian	M
American robin[2]	*Turdus migratorius*	riparian	B
gray catbird[2]	*Dumetella carolinensis*	riparian	B
brown thrasher[2]	*Toxostoma rufum*	riparian	B
sage thrasher	*Oreoscoptes montanus*	shrubland	B
American pipit	*Anthus spinoletta*	grassland	M
bohemian waxwing	*Bombycilla garrulus*	riparian	W
cedar waxwing[2]	*Bombycilla cedrorum*	riparian	B
northern shrike	*Lanius excubitor*	mixed	W
loggerhead shrike[2]	*Lanius ludovicianus*	shrubland	B
European starling[2]	*Sturnus vulgaris*	mixed	B
solitary vireo	*Vireo solitarius*	riparian	M
warbling vireo[2]	*Vireo gilvus*	riparian	B
red-cyed vireo	*Vireo olivaceus*	riparian	B
Tennessee warbler	*Vermivora peregrin*	riparian	M
orange-crowned warbler	*Vermivora celata*	riparian	B
yellow warbler[2]	*Dendroica petechia*	riparian	B
chestnut-sided warbler	*Dendroica pensylvanica*	riparian	M
magnolia warbler	*Dendroica magnolia*	riparian	M
yellow-rumped warbler[2]	*Dendroica coronata*	riparian	B
black-throated blue warbler	*Dendroica caerulescens*	riparian	M
Townsend's warbler	*Dendroica townsendi*	riparian	M
blackpoll warbler	*Dendroica striata*	riparian	M
black-and-white-warbler	*Mniotilta varia*	riparian	M
American redstart	*Setophaga ruticilla*	riparian	B
ovenbird	*Seiurus aurocapillus*	riparian	B
northern waterthrush[2]	*Seiurus noveboracensis*	riparian	M

[1] Expected occurrence: B=breeding resident; M=migrant or occassional visitor through area; W=winter resident; U=uncertain status; H=historical record

[2] Species or evidence of species observed in project area during WEST site visits

Birds Potentially Occuring in the Project Areas

Species	Scientific Name	Habitat	Expected[1] Occurrence
Macgillivray's warbler[2]	*Oporornis tolmei*	riparian	B
common yellowthroat[2]	*Geothlypis trichas*	riparian	B
Wilson's warbler	*Wilsonia pusilla*	riparian	B
yellow-breasted chat	*Icteria virens*	riparian	B
western tanager	*Piranga ludoviciana*	riparian	B
rose-breasted grosbeak	*Pheucticus ludovicianus*	riparian	M
black-headed grosbeak[2]	*Pheucticus melanocephalus*	riparian	B
bluc grosbeak	*Guiraca caerulea*	riparian	M
lazuli bunting[2]	*Passerina amoena*	mixed	B
indigo bunting	*Passerina cyanea*	mixed	M
dickcissel	*Spiza americana*	grassland	M
green-tailed towhee	*Pipilo chlorurus*	mixed	B
rufous-sided towhee	*Pipilo erythrophthalmus*	mixed	B
American tree sparrow	*Spizella arborea*	riparian	W
chipping sparrow	*Spizella passerina*	riparian	B
clay-colored sparrow	*Spizella pallida*	mixed	M
Brewer's sparrow	*Spizella breweri*	shrubland	B
vesper sparrow[2]	*Pooecetes gramineus*	mixed	B
lark sparrow[2]	*Chondestes grammacus*	mixed	B
sage sparrow	*Amphispiza belli*	shrubland	B
lark bunting[2]	*Calamospiza melanocorys*	grassland	B
savannah sparrow[2]	*Passerculus sandwichensis*	grassland	B
grasshopper sparrow	*Ammodramus savannarum*	grassland	B
fox sparrow	*Passerella iliaca*	riparian	B
song sparrow[2]	*Melospiza melodia*	riparian	B
Lincoln's sparrow	*Melospiza lincolnii*	riparian	B
white-throated sparrow	*Zonotrichia albicollis*	riparian	M
white-crowned sparrow[2]	*Zonotrichia leucophrys*	riparian	B
Harris' sparrow	*Zonotrichia querula*	mixed	M
dark-eyed junco[2]	*Junco hyemalis*	mixed	B,M
McCown's longspur	*Calcarius mccownii*	grassland	B
lapland longspur	*Calcarius lapponicus*	grassland	M
chestnut-collared longspur	*Calcarius ornatus*	grassland	M
snow bunting	*Plectrophenax nivalis*	shrubland	W
bobolink[2]	*Dolichonyx oryzivorus*	agriculture	B
red-winged blackbird[2]	*Agelaius phoeniceus*	mixed	B
western meadowlark[2]	*Sturnella neglecta*	mixed	B
yellow-headed blackbird[2]	*Xanthocephalus xanthocephalus*	wetland	B
Brewer's blackbird[2]	*Euphagus cyanocephalus*	shrubland	B

[1] Expected occurrence: B=breeding resident; M=migrant or occassional visitor through area; W=winter resident; U=uncertain status; H=historical record

[2] Species or evidence of species observed in project area during WEST site visits

Birds Potentially Occuring in the Project Areas

Species	Scientific Name	Habitat	Expected[1] Occurrence
common grackle[2]	*Quiscalus quiscala*	mixed	B
brown-headed cowbird[2]	*Molothrus ater*	mixed	B
northern oriole[2]	*Icterus galbula*	riparian	B
orchard oriole	*Icterus spurius*	riparian	M
gray-crowned rosy finch	*Leucosticte tephrocotis*	shrubland	W
black rosy finch	*Leucosticte atrata*	shrubland	W
Cassin's finch	*Carpodacus cassinii*	riparian	W
house finch	*Carpodacus mexicanus*	riparian	B
red crossbill	*Loxia curvirostra*	riparian	W
common redpoll	*Carduelis flammea*	shrubland	W
pine siskin	*Carduelis pinus*	riparian	B
American goldfinch[2]	*Carduelis tristas*	riparian	B
evening grosbeak	*Coccothraustes vespertinus*	riparian	B
house sparrow[2]	*Passer domesticus*	agriculture	B

[1] Expected occurrence: B=breeding resident; M=migrant or occassional visitor through area; W=winter resident; U=uncertain status; H=historical record

[2] Species or evidence of species observed in project area during WEST site visits

Amphibians Potentially Occuring in the Project Areas

Species	Scientific Name
boreal chorus frog	*Pseudacris triseriata*
northern leopard frog[1]	*Rana pipiens*
plains spadefoot	*Scaphiopus bombifrons*
tiger salamander	*Ambystoma tigrinum*
Woodhouse's toad[1]	*Bufo woodhousei*

Reptiles Potentially Occuring in the Project Areas

Species	Scientific Name
bullsnake[1]	*Pituophis melanoleucus*
eastern yellow-belly racer	*Coluber constrictor*
pale milk snake	*Lampropeltis triangulum*
prairie rattlesnake[1]	*Crotalis viridus*
wandering garter snake[1]	*Thamnophis elegans vagrans*
eastern short-horned lizard	*Phrynosoma douglassi*
northern sagebrush lizard[1]	*Sceloperus graciosus*

[1] Species or evidence of species observed in project area during WEST site visits

Fish Potentially Occuring in the Project Areas

Species	Scientific Name
brown trout	*Salmo trutta*
channel catfish	*Ictalurus punctatus*
creek chub[1]	*Semotilus atromaculatus*
flathead chub[1]	*Hybopsis gracilis*
longnose dace[1]	*Rhinichthys cataractae*
longnose sucker[1]	*Catostomus catostomus*
mountain whitefish[1]	*Prosopium williamsoni*
plains killifish[1]	*Fundulus zebrinus*
Snake River cutthroat trout	*Oncorhynchus clarki*
stonecat[1]	*Noturus flavus*
sturgeon chub	*Hybopsis gelida*
shiner species[1]	*Notropis sp.*
walleye	*Stizostedion vitreum vitreum*
white sucker[1]	*Catostomus commersoni*
yellowstone cutthroat trout	*Oncorhynchus clarki*

[1] Species or evidence of species observed in project area during WEST site visits

APPENDIX C

VISUAL SIMULATIONS OF THE PROPOSED ALTERNATIVE DAM SITES

Picture | Page

View from County Road 138 Looking South Toward Lower Roach Gulch Reservoir Site

[Picture 1. actual view]

[Picture 2. simulated view with dam]

View from Near County Road 91 Looking South Toward Blackstone Gulch Reservoir Site

[Picture 1. actual view]

[Picture 2. simulated view with dam]

APPENDIX D

DRAFT BIOLOGICAL ASSESSMENT
OF
ENDANGERED, THREATENED, AND CANDIDATE
SPECIES RELATED TO THE PROPOSED
GREYBULL VALLEY DAM AND RESERVOIR PROJECT

DRAFT BIOLOGICAL ASSESSMENT OF ENDANGERED, THREATENED, AND CANDIDATE SPECIES RELATED TO THE PROPOSED GREYBULL VALLEY DAM AND RESERVOIR PROJECT

Prepared for:

Greybull Valley Irrigation District
Emblem, Wyoming

December 16, 1996

Prepared By:

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INTRODUCTION

The U.S. Fish and Wildlife Service (USFWS) is the primary regulatory agency regarding endangered, threatened, and candidate species. Listed and proposed species receive protection under the amended Endangered Species Act (ESA) of 1973. The current position of the USFWS on candidate species is protection to the fullest extent possible to prevent their listing as threatened or endangered. Many state wildlife agencies and private conservation groups have also expressed a strong interest in monitoring and protecting candidate species and other species of concern. In addition to the ESA, the National Environmental Policy Act (NEPA) of 1969 requires consideration of the environmental consequences, including consideration for protected species, of any federal or federally funded action prior to implementation of that action.

This report was prepared as part of ESA and NEPA compliance for the Lower Roach Gulch Dam and Reservoir project proposed by the Greybull Valley Irrigation District (GVID). This report addresses potential impacts of the project on endangered, threatened, and candidate species that may occur in the area of construction. The following summarizes results of site visits; literature reviews; and file searches of the Wyoming Game and Fish Department (WGFD), the Wildlife Observation System (WOS) maintained by the WGFD, the Wyoming Natural Diversity Data Base (WNDD) maintained by The Nature Conservancy (TNC), the Rocky Mountain Herbarium (RMH) at the University of Wyoming (UW), and the Bureau of Land Management (BLM).

PROJECT DESCRIPTION

The GVID proposes construction and operation of a diversion dam, delivery canal, and off-channel (Greybull River) dam and reservoir to store and manage delivery of Greybull River water for irrigation purposes. The proposed 6-foot-high concrete diversion dam would be located on the Greybull River on private property in T. 50 N., R. 99 W., sec. 11, S1/2SE1/4 at an elevation of approximately 5,098 feet. A 1,000-foot-long earthen training dike would be constructed from the north dam abutment upstream to encompass 100 year flood stage river channels. A 800 cubic-feet-per-second (cfs) capacity sluiceway with steel wall liners would be located at the south edge of the diversion dam. The diversion dam would be designed to allow minimum flow bypasses of 50 cfs and passage of fish during high flows. The diversion canal intake (1,000 cfs capacity) would be located 54 feet south of the sluiceway and would have radial gates. Structures are designed to withstand an unusual flood event (e.g., 100 year flood). Overtopping of the dam in a 100 year flood peak would leave three feet of freeboard along the training dike. Fill for the training dike and for delivery canal construction would be obtained from upland borrow areas and possibly from an agricultural area south of the river on about 60 acres of private lands.

The 5-mile-long, earth-lined delivery canal would have a capacity of 1,000 cfs. It would carry diverted water to a terminal structure located at the southwestern end of the proposed Lower Roach Gulch Reservoir. The canal's typical bottom width would be 15 feet. Twenty irrigation turnouts would be installed along its length to allow delivery of irrigation water to farms along the canal's

route. The canal would be located at the base of the upland benches on the south side of the Greybull River Valley. About one mile of canal would be on BLM lands, and the remainder on private lands. The canal would terminate at approximately 5,015 feet elevation where water would flow into a natural drainage for the last one-half mile drop of 69 feet to the normal reservoir elevation of approximately 4,946 feet.

The proposed Lower Roach Gulch[1] dam would be a 150-foot-high zoned-earth embankment dam with a dam crest elevation of 4950 feet at the mouth of an unnamed gulch west of Roach Gulch. The dam site is located south of the Greybull River primarily in T. 51 N., R. 98 W., sec. 23, SW¼SW¼ on private land. The dam would be approximately 1,720 feet long with a crest width of 25 feet. Dam facilities would include a 150-foot-wide earth channel spillway located on the west abutment, outlet works, discharge canal, and caretaker facilities located below the dam. A concrete parapet wall will be installed on the dam to extend the freeboard to 6 feet above the dam crest. The ephemeral stream channel of the gulch would carry water back to the Greybull River for downstream diversion to the Farmers and Bench Canals. Armor (riprap) would be installed along the banks of the channel to minimize erosion.

The reservoir created by this dam would have a maximum capacity of approximately 33,470 acre-feet with a full pool surface acreage of about 700 acres. Design calls for a minimum conservation pool storage of 834 acre-feet. Operation would result in significant fluctuations in surface acreage and storage pool throughout the year dependent upon stored runoff volume and timing and volume of releases. The dam would retain flood waters in excess of predictable flood events and waves up to 3 feet. Given the relatively unstable slopes associated with the dam site, a construction period of up to two years is proposed to accommodate potential slope instability. The cutoff trench below the dam would extend a maximum depth of 40 feet below grade and a double-line grout curtain would be installed to extend below the cutoff trench.

Minimal recreational facilities (public access route and parking area) are proposed for the project. About 200 acres of private land would need to be acquired for dam construction and access to borrow areas. About 715 acres of BLM land would be necessary for construction access, borrow areas, dam construction access, and reservoir inundated lands. Borrow areas are located within the reservoir site, on adjacent upland benches and badlands, and possibly in agricultural areas.

Wildlife and plant investigations for the site focused on but were not confined to:

- establishing the current status, habitat use, and behavior of endangered, threatened, and candidate species that may occur within the project area based on existing information,

- determining the likelihood of the project adversely affecting endangered and threatened species and jeopardizing candidate species,

[1]The name Lower Roach Gulch is assigned to this proposal because it is referred to by this name in most of the previous documents and reports pertaining to the project and this name is in common use locally, within the agencies, and the GVID

- determining the direct and indirect impacts of the project on endangered, threatened, and candidate species within the project area,
- identifying opportunities for avoiding or mitigating adverse impacts of construction activity,
- determining the expected status of endangered, threatened, and candidate species within the project area after project completion.

METHODS

Descriptions of the project area and habitat are based on site visits and examination of surface photographs and topographic maps. The occurrence and status of endangered, threatened, and candidate species of wildlife within the project area are based on site visits, examination of the WOS and the WNDD, communication and interviews with personnel at WGFD and the BLM, and review of the scientific literature. The occurrence and status of plant species of concern within the project area is based on site visits, specimen records of the RMH, and the WNDD.

Site visits were conducted on October 19, 1994; May 3 and June 5, 27, 1995; May 21-22, June 4-7, June 11-12, August 13, and October 2, 1996 (WEST 1995, 1996). During the visits, foot surveys were conducted within the proposed reservoir, at the proposed dam site, along the proposed canal and return flow routes, in proposed borrow areas, and along the Greybull River corridor between the diversion and return flow. Foot surveys were conducted in all habitat types adjacent to and within the project area. Surveys were concentrated in but not limited to areas where construction or inundation would disturb the existing habitat.

The searches of the WOS and the WNDD included the township in which the project is located as well as all adjacent townships. All sections within these townships were included. The UW computer reference service utilizing the Wildlife and Fish Worldwide Review database from 1971 to the present and the UW computer index were used in review and search of the literature.

PROJECT AREA AND HABITAT DESCRIPTION

The reservoir site is located in "badlands" type habitat adjacent to the riparian corridor of the Greybull River. The canal route to the reservoir follows the base of the hills that divide agriculture and riparian areas from adjacent upland shrubland benches and badlands. The return flow route follows the natural drainage from the gulch to the Greybull River. The dam site is located at the mouth of the gulch where the badlands break to the floodplain of the Greybull River. Property of the project area is a mix of private and federally owned lands. The reservoir site is predominantly land administered by the BLM. The dam site, canal, and return flow routes are predominantly located on private lands.

Topography of the project area varies from relatively flat cultivated fields and river floodplain to steep rocky cuts and ridges of the upland badlands. The area is influenced by the cottonwood riparian and agriculture corridor along the Greybull River. Additionally, there are scattered areas of rural development such as houses, barns, corals, etc. Rangeland throughout the project area exhibits signs of moderate grazing by livestock and wild ungulates. The area receives an annual average precipitation of approximately 8-10 inches (Roberts 1989).

Five major plant communities occur within the project area: mixed grassland-sagebrush shrubland; mixed riparian shrub-shrub steppe; cottonwood riparian; willow riparian shrub; and palustrine wetland. In addition to plant communities, rocky outcrops and ridges with sparse vegetation prevail throughout the reservoir site. Vegetation at the site was mapped using aerial photographs, topographic maps, and ground surveys (Figure 1). Plant communities were mapped on National Wetland Inventory and USGS topographic maps and their acreage was determined using a calibrated digitizer. These calculated areas were supplemented with measures made on-foot during ground surveys. Dominant species within each plant community were recorded during site visits (Table 1). The primary agricultural crop grown in the vicinity of the project area is alfalfa. Other crops grown in the area include native hay, malt barley, small grains, dry beans, and sugar beets.

The mixed grassland-sagebrush shrubland plant community occurs primarily within the reservoir site in areas of moderately steep to flat slope and along the canal route primarily in areas outside the Greybull River floodplain (Figure 1). The mixed riparian shrub-shrub steppe community occurs primarily within the reservoir site along the intermittently flooded stream bed within the gulch and along the outflow channel for return flows to the Greybull River. The cottonwood riparian community occurs along the Greybull River between the point of diversion and the return flows for the project. This plant community is very diverse but was treated as one community for descriptive purposes. The willow riparian shrub community occurs primarily within the cottonwood riparian community along the river. Palustrine wetlands occur primarily along the Greybull River corridor and as a stock pond within the reservoir site. Rocky outcrops and ridges scattered throughout the reservoir site occur primarily in areas of steep slopes. These areas consist primarily of exposed rock and soil with little vegetation; however they provide unique habitat features important to wildlife.

Figure 1. Habitat types within the proposed Greybull Valley Irrigation District Dam and Reservoir project area.

Table 1. List of the dominant plant species for each plant community in the Lower Roach Gulch project area.

Plant Community	Species Present	Approximate Acreage
mixed grassland-sagebrush shrubland	big sagebrush (Artemisia tridentata) silver sagebrush (Artemisia cana) bluebunch wheatgrass (Agropyron spicatum) Indian ricegrass (Oryzopsis hymenoides) needle-and-thread (Stipa comata) cheatgrass (Bromus tectorum) blue grama (Bouteloua gracilis) smooth brome (Bromus inermis) prairie junegrass (Koeleria cristata) crested wheatgrass (Agropyron cristatum) western wheatgrass (Agropyron smithii) squirreltail (Sitanion hystrix) western needlegrass (Stipa occidentalis) annual false wheatgrass (Eremopyrum triticeum) basin wild rye (Elymus cinereus) tall fescue (Festuca arundinacea) broom snakeweed (Gutierrezia sarothrae) curlycup gumweed (Grindelia squarrosa) pricklypear (Opuntia polycantha) buckwheat (Eriogonum spp.) saltbush (Atriplex sp.) aster (Aster spp.) greasewood (Sarcobatus vermiculatus) alkali sacaton (Sporobolus aeroides) green rabbitbrush (Chrysothamnus viscidiflorus) darnel (Lolium sp.)	551.0
mixed riparian shrub-shrub steppe	baltic rush (Juncus balticus) three-square bulrush (Scirpus pungens) alkali cordgrass (Spartina gracilis) cheatgrass (Bromus tectorum) intermediate wheatgrass (Agropyron intermedium) foxtail barley (Hordeum jubatum) inland saltgrass (Distichlis spicata) sandbar willow (Salix exigua) Russian thistle (Salsola kali) common cocklebur (Xanthium strumarium) narrowleaf cottonwood (Populus angustifolia) wild licorice (Glycyrrhiza lepidota) tamarisk (Tamarix chinensis)	19.0
palustrine wetland	foxtail barley (Hordeum jubatum) sandbar willow (Salix exigua) tamarisk (Tamarix chinensis) plains cottonwood (Populus deltoides) narrowleaf cottonwood (Populus angustifolia) Canada thistle (Cirsium arvense) cocklebur (Xanthium strumarium) Kentucky bluegrass (Poa pratensis)	1.8

Plant Community	Species Present	Approximate Acreage
cottonwood riparian	cattail (Typha latifolia) Nebraska sedge (Carex nebraskensis) foxtail barley (Hordeum jubatum) smooth scouringrush (Equisetum laevigatum) baltic rush (Juncus balticus) sandbar willow (Salix exigua) rabbitfoot grass (Polypogon monspeliensis) softstem bulrush (Scirpus validus) three-square bulrush (Scirpus pungens) canary reedgrass (Phalaris arundinaceus) rough bugleweed (Lycopus asper) wild licorice (Glycyrrhiza lepidota) clover (Trifolium sp.) dandelion (Taraxacum officinale) Canada thistle (Cirsium arvense) narrowleaf cottonwood (Populus angustifolia) wild rose (Rosa woodsii) yellow sweetclover (Melilotus officinale) duckweed (Lemna minor) fowl bluegrass (Poa palustris) barnyard grass (Echinochloa muricata) timothy (Phleum pratense) musk thistle (Carduus nutans) wheatgrass (Agropyron sp.) smooth brome (Bromus inermis) plantain (Plantago sp.) Russian olive (Eleagnus angustifolia) juniper (Juniperus sp.)	222.0
willow riparian shrub	sandbar willow (Salix exigua) wild licorice (Glycyrrhiza lepidota) clover (Trifolium sp.) dandelion (Taraxacum officinale) Canada thistle (Cirsium arvense) smooth scouringrush (Equisetum laevigatum) narrowleaf cottonwood (Populus angustifolia) wild rose (Rosa woodsii) white-blossom sweetclover (Melilotus alba)	10.0

Wildlife in the project area is diverse due to the variety of habitat types. The variety of plant communities, topography, soils, and water resources in the Lower Roach Gulch project area provide habitats for a variety of terrestrial and aquatic species. As with plants, wildlife observed during site visits was recorded (Table 2).

Table 2. Wildlife recorded during site visits to the Lower Roach Gulch project area.

Species	Habitat	Status[a]
Mammals		
desert cottontail (Sylvilagus audubonii)	mixed	B
least chipmunk (Sciurus minimus)	mixed	B
beaver (Castor canadensis)	riparian	B
bushy-tailed woodrat (Neotoma cinerea)	rocky areas	B
raccoon (Procyon lotor)	riparian	B
coyote (Canis latrans)	mixed	B
striped skunk (Mephitis mephitis)	mixed	B
badger (Taxidea taxus)	shrubland	B
bobcat (Lynx rufus)	mixed	B
pronghorn (Antilocapra americana)	shrubland	B
mule deer (Odocoileus hemionas)	mixed	B
white-tailed deer (Odocoileus virginianus)	riparian	B
moose (Alces alces)	riparian	B
Birds		
great blue heron (Ardea herodius)	wetland, riparian	B
Canada goose (Branta canadensis)	mixed, water	B
wood duck (Aix sponsa)	riparian	B
mallard (Anas platyrhynchos)	mixed, water	B
green-winged teal (Anas crecca)	marshes, lakes	B
blue-winged teal (Anas discors)	marshes, lakes	B
northern shoveler (Anas clypeata)	marshes, lakes	B
Say's phoebe (Sayornis saya)	shrubland	B
common merganser (Mergus merganser)	rivers, lakes	B
Cooper's hawk (Accipiter cooperi)	riparian	B
Swainson's hawk (Buteo swainsoni)	mixed	B
red-tailed hawk (Buteo jamaicensis)	mixed	B
golden eagle (Aquila chrysaetos)	mixed	B
prairie falcon (Falco mexicanus)	shrubland	B
American kestrel (Falco sparverius)	mixed	B
gray partridge (Perdix perdix)	mixed	B
sage grouse (Centrocercus urophasianus)	shrubland	B
ring-necked pheasant (Phasianus colchicus)	riparian	B
sandhill crane (Grus canadensis)	marshes, meadows	B
killdeer (Charadrius vociferus)	river, ponds	B
spotted sandpiper (Actitis macularia)	river, ponds	B
common snipe (Gallinago gallinago)	marshes, meadows	B
rock dove (Columba livia)	mixed	B
mourning dove (Zenaida macroura)	mixed	B
great horned owl (Bubo virginianus)	mixed	B
common nighthawk (Chordeiles minor)	shrubland	B
white-throated swift (Aeronautes sexatalis)	mixed, cliffs	B
belted kingfisher (Ceryle alcyon)	riparian	B
northern flicker (Colaptes auratus)	riparian	B
downy woodpecker (Picoides pubescens)	riparian	B
cedar waxwing (Bombycilla cedrorum)	riparian	B

Species	Habitat	Status[a]	Species	Habitat	Status[a]
western wood pewee (Contopus sordidulus)	riparian	B	loggerhead shrike (Lanius ludovicianus)	shrubland	B,M
least flycather (Empidonax minimus)	riparian	B	European starling (Sturnus vulgaris)	mixed	B
eastern kingbird (Tyrannus tyrannus)	shrubland	B	warbling vireo (Vireo gilvus)	riparian	B
horned lark (Eromophila alpestris)	grassland	B	yellow warbler (Dendroica petechia)	riparian	B
violet-green swallow (Tachycineta thalassina)	riparian	B	yellow-rumped warbler (Dendroica coronata)	riparian	B
cliff swallow (Hirundo pyrrhonota)	mixed	B	Macgillivray's warbler (Oporornis tolmei)	riparian	B
n. rough-winged swallow (Stelgidopteryx serripennis)	mixed	B	black-headed grosbeak (Pheuticus melanocephalus)	riparian	B
barn swallow (Hirundo rustica)	mixed	B	lazuli bunting (Passerina amoena)	mixed	B
tree swallow (Tachycineta bicolor)	mixed	B	vesper sparrow (Pooecetes gramineus)	mixed	B
American crow (Corvus brachyrhynchos)	mixed	B	lark sparrow (Chondestes grammacus)	mixed	B
black-billed magpie (Pica pica)	mixed	B	white-crowned sparrow (Zonotrichia leucophrys)	riparian	B
common raven (Corvus corax)	mixed	B,W	Savannah sparrow (Passerculus sandwichensis)	grassland	B
mountain chickadee (Parus gambeli)	riparian	B,W	Song sparrow (Melospiza melodia)	riparian	B
black-capped chickadee (Parus atricapillus)	riaprian	B	lark bunting (Calamospiza melanocorys)	grassland	B
white-breastd nuthatch (Sitta carolinensis)	riparian	B	dark-eyed junco (Junco hyemalis)	mixed	B,M
rock wren (Salpinctes obsoletus)	shrubland, rock	B	western meadowlark (Sturnella neglecta)	mixed	B
house wren (Troglodytes aedon)	riparain	B	Brewer's blackbird (Euphagus cyanocephalus)	shrubland	B
mountain bluebird (Siala curricoides)	shrubland	B,M	red-winged blackbird (Agelaius phoeniceus)	mixed	B
Swainson's thrush (Catharus ustulatus)	riparian	B	yellow-headed blackbird (X. xanthocephalus)	wetland	B
American robin (Turdus migratorius)	riparian	B,M	common grackle (Quiscalus quiscala)	mixed	B
gray catbird (Dumetella carolinenesis)	riparian	B	brown-headed cowbird (Molothrus ater)	mixed	B
brown thrasher (Toxostoma rufum)	riparian	B	northern oriole (Icterus galbula)	riparian	B
bobolink (Dolichonyx oryzivorus)	agriculture	B	bullsnake (Pituophis melanoleucus)	mixed	B

Species	Habitat	Status[a]	Species	Habitat	Status[a]
American goldfinch (Carduelis tristas)	riparian	B	wandering garter snake (Thamnophis elegans)	mixed	B
house sparrow (Passer domesticus)	mixed	B	northern leopard frog (Rana pipiens)	wetland	B
Reptiles & Amphibians			Woodhouse's toad (Bufo woodhousei)	wetland	B
n. sagebrush lizard (Sceloperus graciosus)	shrubland	B			

a expected status: B = breeding resident; U = unknown status; M = migrant or occasional visitor through area; W = winter resident

STATUS, HABITAT, AND BEHAVIOR OF SPECIES OF CONCERN

Table 3 lists the endangered, threatened, and candidate species that may possibly occur within the project area. The list was provided by USFWS personnel in response to the proposed project. The table summarizes the status and expected occurrence of each species as it relates to the proposed reservoir project.

The results of the site visits, WOS and WNDD system searches, scientific literature search, and communication with agency personnel are summarized for each species. Additionally, the current known status and preferred habitat of each species is reviewed below.

Endangered and Threatened Species:

Black-footed ferret - Black-footed ferrets require prairie dog colonies for their existence. Historically, they occurred wherever prairie dogs were found (Clark et al. 1984, Forrest et al. 1985) from southern Canada to New Mexico and Texas (Anderson et al. 1986, Forrest et al. 1985). Availability of prairie dog towns is the limiting factor for good ferret habitat (Forrest et al. 1985).

In Wyoming, only one experimental population of ferrets exists and is located in the Shirley Basin (Oakleaf and Luce 1992). Black-footed ferrets historically occurred in the Greybull River area. The last known wild population of ferrets was found west of Meteetsee on the Pitchfork Ranch approximately 30 miles west of the project area. There are historical observations of black-footed ferrets in the latilong (a latilong represents a rectangle of 1 degree latitude and 1 degree longitude) in which the project area occurs (Oakleaf et al. 1992), and Clark and Stromberg (1987) include the project area in the range of ferrets; however, no observations of this species in the area have been reported to the WOS or WNDD. Current existence of ferrets on or near the project site is doubtful, as no prairie dog colonies occur within the project area.

Bald Eagle - Historically, bald eagles occurred over most of North America in a variety of habitats. Generally, they require areas in the proximity of water for nesting and areas with abundant readily available food sources and good roost sites during winter. Roosts are generally old large trees where

visibility is good and human disturbance is low (Green 1985). In Wyoming, bald eagles are listed as an uncommon resident and usually occur in coniferous forest in the northwestern portion of the state (B. Oakleaf, WGFD, personal communication). In the winter, the population of bald eagles in Wyoming increases due to an influx of migrants from the north. Wintering eagles are primarily found in open areas near water where they feed on fish and waterfowl (Oakleaf et al. 1991).

Table 3. Endangered, threatened, candidate species which may potentially occur or are known to occur in the project area.

Species	Status	Habitat	Occurrence
Mammals			
Black-footed Ferret (Mustela nigripes)	Endangered	prairie dog colonies	historical observations in latilong of project (Clark and Stromberg 1987)
Allen's thirteen-lined ground squirrel (Spermophilus tridecemlineatus alleni)	Former Category 2 Candidate	shortgrass prairie, transitional zones	potential resident Big Horn basin (Clark and Stromberg 1987)
Small-footed bat (Myotis ciliolabrum)	Former Category 2 Candidate	sage steppe, shortgrass, rocky outcrops, caves, mines	observed in latilong of project (Oakleaf et al. 1992)
Yuma bat (Myotis yumanensis)	Former Category 2 Candidate	riparian areas, man-made structures	observed in latilong of project (Oakleaf et al. 1992)
Long-legged bat (Myotis volans)	Former Category 2 Candidate	forests, shrublands, riparian areas	observed in latilong of project (Oakleaf et al. 1992)
Long-eared bat (Myotis evotis)	Former Category 2 Candidate	coniferous forest, cottonwood riparian	suspected breeder in latilong of project (Oakleaf et al. 1992)1
Townsend's big-eared bat (Plecotus townsendii)	Former Category 2 Candidate	desert shrubland, juniper woodlands, caves	suspected breeder in latilong of project (Oakleaf et al. 1992)
Spotted bat (Euderma maculatum)	Former Category 2 Candidate	low desert, shrub-scrub habitats, coniferous forest, open fields, canyon lands, cliffs	suspected breeder in latilong of project (Oakleaf et al. 1992)
Birds			
Bald eagle (Haliaeetus leucocephalus)	Threatened	coniferous forest, cottonwood riparian, water	two observations in project area 3/30/85, 1/15/95 (WGFD 1995a)
Peregrine falcon (Falco peregrinus)	Endangered	cliffs near shorebird/ waterfowl habitat	suspected breeder in latilong of project, expected migrant through area (Oakleaf et al. 1992)
Mountain plover (Charadrius montanus)	Candidate	shortgrass prairie, flat topography	breeder in latilong of project (Oakleaf et al. 1992)

Species	Status	Habitat	Occurrence
White-faced ibis (Plegadis chihi)	Former Category 2 Candidate	marshes, wet meadows	observed in Greybull Valley (WGFD 1995a)
Ferruginous hawk (Buteo regalis)	Former Category 2 Candidate	sagebrush steppe, grasslands	breeder at LRG 6/13/90 (WGFD 1990), numerous observations in project area (WGFD 1995a)
Loggerhead shrike (Lanius ludovicianus)	Former Category 2 Candidate	shrublands	breeder at LRG 6/5/95, 6/27/95 (WEST 1995)
Western burrowing owl (Spcotyto cunicularia)	Former Category 2 Candidate	shrublands, grasslands, agriculture	breeder in latilong of project (Oakleaf et al. 1992)
Black tern (Chlidonias niger)	Former Category 2 Candidate	marshes, aquatic habitats	observed in latilong of project (Oakleaf et al. 1992)
Reptiles			
Eastern short-horned lizard (Phrynosoma douglassi)	Former Category 2 Candidate	sagebrush, grasslands	no records, habitat suitable
Fish			
Sturgeon Chub (Hybopsis gelida)	Candidate	highly turbid rivers	recorded near Yellowtail Reservoir 1981 (WGFD data), no sturgeon chub found in Greybull River (WEST Team 1995)
Plants			
Persistent sepal yellowcress (Rorippa calycina)	Former Category 2 Candidate	mudflats, alkali beaches, sandy shores	one specimen at Schuster Flats 20 miles SE of project (RMH 1995), no observations in project area

Bald eagles have been documented breeding in the latilong region in which the project area occurs (Oakleaf et al. 1992); however, there are no known nesting records for bald eagles in the Greybull River Valley. There are 35 records of bald eagles along the Greybull river between Meteetsee and the confluence of the Greybull and Bighorn Rivers in the WOS. These records occurred between the months of October and April. It is assumed that these bald eagles were wintering in the area; however, there are no known winter concentration areas for the Greybull River Valley (B. Oakleaf, WGFD, personal communication). There are two records of bald eagle documented within the Lower Roach Gulch project area in the WOS. One sighting was made on 30 March 1985 in T. 51 N., R. 98 W., sec. 28, NE¼ which is located along the Greybull River approximately one mile west of the proposed reservoir site. The second sighting was in T. 50 N. R. 99 W., sec. 12, SW¼. This observation was made on 15 January 1982 along the Greybull River near the proposed location of the diversion dam. No observations of bald eagles were made during site visits.

Peregrine Falcon - Historically, peregrine falcons occurred worldwide in a variety of habitats. Typically they are found near expansive areas of shorebird and/or waterfowl habitat where cliffs are usually the dominant feature of the landscape (Skaggs et al. 1988). In Wyoming, they are found near cliffs generally in the northwestern portion of the state (B. Oakleaf, WGFD, personal communication) and are listed as a rare resident (Oakleaf et al. 1992).

There is circumstantial evidence that peregrine falcons breed in the latilong region of the project area, but breeding has not been confirmed (Oakleaf et al. 1992). There are no records of peregrine falcons in the general vicinity of the Lower Roach Gulch project area in either the WOS or WNDD databases. However, it is expected that peregrines migrate through the area (B. Oakleaf, WGFD, personal communication). The riparian corridor of the Greybull River could provide foraging habitat for migrant peregrine falcons. Peregrine falcons were not observed during site visits to the project area.

Candidate Species:

The USFWS requests that Candidate species be considered during construction activities to protect them from further population declines. Prior to July 19, 1995, candidate species were defined by the USFWS as:

Category 1: Federal T/E listing appears appropriate and is anticipated.

Category 2: Current data are insufficient to support listing.

Category 3C: More widespread or abundant than previously believed, or no immediate threats identified.

As of July 19, 1995, the USFWS Director issued new policy with respect to candidate species. Under the new policy, candidate species were redefined to mean only those species for which the USFWS has sufficient information indicating that listing may be appropriate. The new policy, therefore, considers only those species that were classified as a category 1 candidate under previous candidate species definitions. Despite this new policy change, the USFWS continues to encourage policies to ensure protection of species previously classified as category 2 candidate species. Therefore, this biological assessment addresses effects of the project on category 2 species as well as category 1 species.

Based on location and habitat, the only candidate species under the new policy which may occur in the area are mountain plover and sturgeon chub. Species previously considered category 2 candidate species possibly occurring in the area include Allen's thirteen-lined ground squirrel, Townsend's big-eared bat, spotted bat, small-footed bat, long-eared bat, long-legged bat, yuma bat, white-faced ibis, ferruginous hawk, western burrowing owl, black tern, loggerhead shrike, eastern short-horned lizard, and persistent sepal yellowcress.

Mountain Plover - The USFWS has been petitioned to list the mountain plover as endangered under the ESA and listing this species as threatened or endangered is anticipated. The preferred habitat of mountain plover is shortgrass prairies and grassland dominated by blue grama and buffalograss, but they may be observed in other habitats during migration (Dinsmore 1983, Bent 1962). Olson-Edge and Edge (1987) noted a strong association of mountain plovers and prairie dog towns. They also noted that irregular topography and tall vegetation precluded habitat use by this species.

In Wyoming, this bird is listed as a common summer resident (Oakleaf et al. 1992), and the WGFD has documented that this species breeds in the latilong region of the project (Oakleaf et al. 1992). Each component of the project was evaluated for habitat features that meet the requirements of this species. Mountain plovers have been recorded in the general vicinity of the project (WGFD 1995a); however, there is no suitable habitat based on vegetation structure and topography within the Lower Roach Gulch project area.

Sturgeon Chub - The sturgeon chub prefers highly turbid water with clean substrate and potentially occurs in the Greybull River. It was recently upgraded from a Category 2 to a Category 1 species (Federal Register 1994, USFWS 1993). No records exist indicating that the sturgeon chub is present in the Greybull River. In the Bighorn Basin, the most recent collection of this species was near Yellowtail Reservoir in 1981 (WGFD unpublished data), which is approximately 30 river miles downstream of the Greybull-Bighorn River confluence. There have been no reports of sturgeon chub in the Bighorn Basin since 1981; therefore, the present status of the sturgeon chub in the lower Greybull and lower Bighorn Rivers is unknown.

During surveys in the spring and summer of 1995 on the lower Greybull River conducted by the WEST Team (1995) populations of longnose dace and flathead chubs were found, species that occur in habitats similar to that of the sturgeon chub. However, no sturgeon chubs were collected from sites considered to be good sturgeon chub habitat based on habitat studies in rivers where sturgeon chubs have been collected.

The absence of sturgeon chubs may indicate that one or more obligate life requisites such as high turbidity, swift waters, or clean substrates may be missing or are not adequate in the lower Greybull River. Other factors may singly or in combination contribute to the lack of sturgeon chub in these waters, including: (1) the Greybull River is at the edge of the natural range of this species, (2) the Greybull River may be too small for the sturgeon chub, and (3) the large daily flow variations that occur during the irrigation season may be intolerable to sturgeon chub.

Former Category 2 Species

Allen's thirteen-lined ground squirrel is one of four subspecies of thirteen-lined ground squirrel which occur in Wyoming (Clark and Stromberg 1987). Allen's subspecies occurs in the Big Horn Mountains and Big Horn Basin and is considered rare (Clark and Stromberg 1987, Oakleaf et al. 1992). Allen's thirteen-lined ground squirrels were historically found in transitional life zones

(sagebrush grassland to coniferous forest) at the upper reaches of drainages (Long 1965) and in areas of generally unbroken shortgrass prairie (M. Atkins, BLM, personal communication). The project area does not provide suitable habitat for this species based on available information.

Townsend's big-eared bats occur throughout Wyoming in desert shrublands, pinyon-juniper woodlands and dry coniferous forest. They use caves for both day roosts and hibernation sites, and may use buildings for night roosts (Clark and Stromberg 1987). This species has been observed in the latilong of the project, and breeding is suspected but has not been confirmed (Oakleaf et a. 1992). Suitable habitat for this species occurs in the project area.

Spotted bats occur in a variety of habitats including low desert, shrub-scrub habitats, coniferous forest, open fields, canyon lands, and cliffs over water (Navo et al. 1992, Hasenyager 1980, Leonard and Fenton 1983) and at a wide variety of altitudes up to greater than 10,000 feet (Reynolds 1981). In Wyoming, they are known from several records in the vicinity of the Bighorn National Recreation Area, but are believed to occur over most of the western portion of the state due to their extended range from Mexico to British Columbia (Clark and Stromberg 1987, Genter 1989). They are believed to inhabit primarily ponderosa pine, juniper, and dry sagebrush habitats in Wyoming (B. Luce, WGFD, personal communication). This species was not documented in the project area; however, habitat is likely suitable for this species.

The small-footed bat has been captured throughout Wyoming, and can be expected from montane forests to sage steppes or shortgrass prairie near rock outcrops where it feeds over water (Clark and Stromberg 1987). This species hibernates in caves and mine shafts and often has nurseries in buildings. Its residency status in Wyoming is uncertain and it is considered uncommon. There are records of this species in the latilong in which the project occurs, and it is assumed this species breeds in this latilong (Oakleaf et al. 1992). Rock outcrops in association with the Greybull River may provide habitat for this species in the project area.

Preferred habitat of the long-eared bat is coniferous forest, especially ponderosa pine, where it roosts in caves, buildings, and mine tunnels (Clark and Stromberg 1987). Other habitats used by this species include juniper, cottonwood-riparian, basin-prairie shrublands, and sagebrush grasslands (Oakleaf et al. 1992). There are records of this species in the latilong in which the project occurs, and it is assumed this species breeds in this latilong (Oakleaf et al. 1992). Habitats for this species are present in the project area.

Long-legged bats are considered abundant in Wyoming (Clark and Stromberg 1982). Habitats used by this species include coniferous and deciduous forests, basin-prairie and mountain-foothills shrublands, and riparian areas. They roost in tree crevices, snags, buildings, rock crevices, mines and caves. This species also has been documented in the latilong in which the project occurs; however, there is no documentation that it breeds in this area (Oakleaf et al. 1992). Habitat in the project area is suitable for this species.

The yuma bat has been collected at Sheridan and likely occurs in drier basins of the Green, Wind, and Bighorn Rivers. It is generally limited to riparian areas. This species often roosts in man-made structures including bridges, mines, and caves (Clark and Stromberg 1987). The status of this species in the state is uncertain. It has been observed in the latilong in which the project occurs, but breeding has not been documented (Oakleaf et al. 1992). The Greybull River riparian corridor may provide habitat for this species.

White-faced ibis typically occur in marshes and wet meadows and grassland. In Wyoming, they are listed as an uncommon summer resident, where they usually nest in bulrushes or cattails (Oakleaf et al. 1992). This species has been observed in the latilong region of the project but is not known to nest there (Oakleaf et al. 1992). There are two records of white-faced ibis in the general vicinity of the project area in the WOS. There are scattered areas of suitable habitat in the form of marshes and wet meadows for white-faced ibis along the Greybull River.

Ferruginous hawks primarily inhabit grasslands and sagebrush, and nest in small conifers, cliffs, rock outcrops, and man-made structures (Johnsgard 1986). In Wyoming, ferruginous hawks are considered a yearlong resident; however, they are more common in the summer than in the winter. Breeding by this species has been documented in the latilong in which the project occurs (Oakleaf et al. 1992), and there are 10 records of ferruginous hawks in the WOS and WNDD in the general vicinity of the project. Juvenile ferruginous hawks were observed by WGFD biologists in close proximity to the canal leading to the reservoir site; however, the nest site could not be located (WGFD 1990). Habitat in the area to be inundated by the reservoir is suitable for ferruginous hawks.

Burrowing owls occupy basin-prairie shrublands, grasslands and agricultural areas throughout much of Wyoming. They are closely tied to mammal burrows, especially those of prairie dogs (Johnsgard 1986). They are considered an uncommon summer resident in Wyoming. Although they have been documented breeding in the latilong in which the project occurs (Oakleaf et al. 1992), there are no WOS records in the immediate vicinity of the project sites. Although there are no prairie dog towns, burrowing owls could occupy ground squirrel or other small mammal burrows in the project area.

Black terns are generally found near marshes and other aquatic settings where they nest on floating vegetation or muskrat houses (Johnsgard 1986). They are listed as a common summer resident in Wyoming (Oakleaf et al. 1992). This species has been observed in the latilong of the project but there is no evidence to indicate this species breeds in this area (Oakleaf et al. 1992). Although there are no known records of black terns from the Greybull Valley, there is probably some suitable habitat in the form of marshes along the Greybull River.

Loggerhead shrikes are generally found in open or brushy areas with scattered cover and perch sites (Dorn and Dorn 1990, Johnsgard 1986). In Wyoming they are considered a common summer resident and are found in pine-juniper, woodland chaparral, and mountain-foothill shrublands (Oakleaf et al. 1992). Loggerhead shrikes feed primarily on insects. Preferred nesting sites in shrublands include big sagebrush, bitterbrush, and greasewood plants (Woods 1993). In Wyoming, nesting

records occur from 29 May to 12 June (Johnsgard 1986). Four loggerhead shrikes were observed during the migration period (3 May 1995) in the area to be inundated by the proposed reservoir. One loggerhead shrike nest containing seven eggs was located in the reservoir site on 5 June 1995, and a second shrike nest containing three fledglings was located in the reservoir site on 27 June 1995.

The eastern short-horned lizard occurs commonly throughout most of Wyoming in grasslands and sagebrush communities below 6500 feet in elevation. It prefers flat, arid habitats with firm soil (Baxter and Stone 1980). Sagebrush communities within the area to be inundated at the reservoir site and uplands associated with canals may provide habitat for this species.

With the exception of some historical records in Montana and some remaining occurrences in northern Canada, nearly the entire range of persistent sepal yellowcress is found in Wyoming near Boysen, Seminoe, and Buffalo Bill Reservoirs and in the Bighorn Basin around small stock ponds (RMH specimen records 1995). Persistent sepal yellowcress is typically found on mudflats where water levels fluctuate. Habitats where specimens have been collected in Wyoming include exposed mudflats, alkali beaches, sandy slopes, and rocky shorelines adjacent to reservoirs; creek flood plains; sandy river banks and temporary ponds (RMH specimen records 1995). In Park County, this species has been collected along shorelines of Buffalo Bill Reservoir. Closer to the project area, there was a specimen collected near Schuster Flats in T. 48 N., R. 93 W., sec. 5, in association with a dry reservoir. This site is located over 20 miles southeast of the project. The most likely habitat for this species in the project area would be the shoreline of the stock pond present in the reservoir site. This area was surveyed for persistent sepal yellowcress in June 1995 and no specimens were located. No records of this species occur in the project area in the WNDD.

IMPACT OF PROPOSED PROJECT ON SPECIES OF CONCERN AND SUGGESTED MITIGATION

There are several impacts that may occur from the dam and reservoir project on wildlife species including species of concern. These include indirect impacts from increased human presence and activity during construction; loss of habitat or habitat alteration due to construction activity and reservoir inundation; and direct impacts on species from flooding and excavation resulting in displacement and mortality. Long-term changes in habitat may also benefit some species.

Endangered and Threatened Species:

Black-footed Ferret - Prairie dog colonies, the primary habitat for black-footed ferrets, have not been documented at the proposed reservoir site, borrow areas, diversion dam, along the canal route, or along the return flow route. Because no impacts to prairie dog towns will occur as a result of this project, there are no anticipated impacts to black-footed ferrets.

Bald Eagle - Evidence of bald eagles in the area is predominantly limited to winter months. There are no known nests or regular winter roosts in the project area. Winter construction activity and disturbance may displace wintering bald eagles in the project area.

Wintering bald eagles in the project area probably forage on fish and waterfowl along the Greybull River and on winter killed big game. Reservoir construction is not expected to adversely affect the availability of winter-killed big game, waterfowl, or fish in the Greybull River, and is therefore not expected to indirectly affect bald eagles. Creation of the reservoir may improve habitat for bald eagles to the extent that the reservoir provides habitat for waterfowl and/or fish, as these are primary sources of food for wintering eagles.

Construction activities for this project have the potential to affect fish availability in the Greybull River due to construction in the river at the diversion dam and through sediment loads and pollutants entering the river from run-off during construction. To reduce impacts to fish, proper erosion control measures should be taken to prevent sediment and/or spills of fuels/oils from entering the Greybull River or adjacent irrigation ditches. If proper protective measures are employed, construction activity is not expected to adversely affect fish availability in the Greybull River.

Peregrine Falcon - There are no documented occurrences of peregrine falcons in the project area, and the project area does not provide suitable nesting habitat in the form of cliffs. Use of the project area by this species is likely limited to occasional migrants through the area. Additionally, there are no large concentrations of waterfowl or shorebirds within the project area to attract peregrines for extended periods. Reservoir construction is not expected to adversely affect peregrine falcons. As with bald eagles, a new reservoir in the area could improve habitat for this species to the extent that it provides habitat for waterfowl and shorebirds, the primary prey of peregrines.

Candidate Species:

Mountain Plover - Habitat throughout the project area is not suitable for mountain plovers. Mountain plovers show a strong affinity for flat areas with low vegetation. Irregular topography and tall vegetation appear to inhibit use of the project area by this species. No impacts to this species are expected from the project.

Sturgeon Chub - Based upon past collection records and present data (WGFD unpublished data, WEST Team 1995), there is no conclusive evidence that the sturgeon chub is part of the Greybull River ichthyofauna. Assuming this to be true, construction and operation of the reservoir will have no effect on this species.

Former Category 2 Species

Habitat in the project area is unsuitable for Allen's thirteen-lined ground squirrel; therefore, no impacts to this species are expected. No critical habitat for bats (e.g. caves, roosts) was documented

in the project area. Most use of the project area by bats likely occurs along the Greybull River which will not be significantly impacted by project activities.

Suitable habitat in the Greybull River Valley for white-faced ibis and black tern is primarily along the Greybull River. Although some minimal wetland loss may occur along the river, the loss represents only a small fraction of those wetlands available, and presence of a reservoir will provide additional wetlands and thus habitat for these species.

Ferruginous hawks have been documented to breed in the project area, but nesting locations have not been confirmed. Inundation of the reservoir and disturbance at borrow areas would result in the loss of ferruginous hawk nesting and foraging habitat. These habitats in the Greybull River Valley are abundant and are not believed to be a limiting factor for this species.

Loggerhead shrikes were frequently observed in the project area and were documented breeding within the area to be inundated during the summer of 1995. Inundation of the reservoir will eliminate future breeding by this species at this site. Loggerhead shrikes use a variety of shrubs and trees for breeding, and these habitat types are abundant throughout the Greybull River Valley and adjacent areas. Therefore, loss of the Lower Roach Gulch project area as a breeding site will not likely reduce populations of this species in the Greybull River Valley.

Construction of the reservoir will result in some habitat loss for western burrowing owl and eastern short-horned lizard and may result in the death of individual short-horned lizards within the area that will be inundated or disturbed by construction equipment. However, these species were not documented in the project area and no significant impacts to these species are expected.

Persistent sepal yellowcress was not documented in the project area during ground surveys. Because habitat of this species is on mudflats where water levels fluctuate, construction of the reservoir will likely increase habitat for this plant in the project area.

DETERMINATION OF EFFECT OF THE PROJECT ON SPECIES OF CONCERN

Based on the above information, the Greybull Valley Dam and Reservoir project in the lower Greybull River Valley is not likely to adversely affect the endangered or threatened species and is not likely to jeopardize the continued existence of candidate species that may occur in the project area.

SUMMARY

The GVID is proposing to construct a dam and reservoir in the lower portion of an unnamed gulch for the purpose of storing water for irrigation. Associated components of the project include a diversion dam on the Greybull River, an approximately 5-mile-long canal to deliver water to the

reservoir, armoring of the existing channel to return flows to the Greybull River, various borrow areas, and facilities associated with the dam. A list of endangered, threatened, and candidate species that could potentially be found in the project area was generated. To investigate the possibility of adverse effects to these species, site visits, communication with WGFD and BLM personnel, and searches of the WGFD WOS, the TNC WNDD, and scientific literature were conducted. Bald eagles in the project area were documented through recent observations. Peregrine falcons are potential migrants through the area and black-footed ferrets historically occupied range that overlaps that of the project area. There are no prairie dog colonies in the project area precluding current use by black-footed ferrets. Mountain plovers inhabit habitat types not found in the project area and sturgeon chub has not been documented in the Greybull River. Of the former category 2 candidate species, ferruginous hawk and loggerhead shrike were documented in the project area. Townsend's big eared bat, spotted bat, small-footed bat, long-eared bat, long-legged bat, yuma bat, white-faced ibis, western burrowing owl, black tern, eastern short-horned lizard, and persistent sepal yellowcress occupy habitat types that are found within the project area. These species have not been documented in the area and habitat occupied by these species is abundant throughout the Greybull River Valley. Effects to concerned species were determined to be none or minimal. Conservation practices which avoid impacts to the Greybull River, such as measures to prevent sediment and/or fuel/oil spills from running into the river, should be employed. Because of the small likelihood of the proposed project having an impact on any of the concerned species, the status of the species both long and short term, is not expected to change due to the project.

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